(NASA-CR-143638) LK21T1 S/N V-3 INFRARED DETECTOR (Honeywell, Inc.) 34 p HC $3.75 CSCL 14B
N75-15954
Unclas
G3/35 09590

TEST REPORT NO. 24121-2

FOR

LK21T1 S/N V-3 INFRARED DETECTOR

FOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

CONTRACT NO. NAS5-21961

BY

HONEYWELL INC.
RADIATION CENTER
2 FORBES ROAD
LEXINGTON, MASSACHUSETTS 02173

TABLE OF CONTENTS

INTRODUCTION

The detector reported herein was fabricated to determine the feasibility of atmospheric sounding from synchronous orbit for water vapor and carbon dioxide.

The device was extensively tested both before and after a 24-hour soak at 50°C and relative humidity of 95 percent. No degradation in performance as a result of the "soak" was observed. Although not intended for space flight use, this detector was fabricated to Honeywell's High Reliability Workmanship Standards.

The device contains a single Photoconductive HgCdTe element designed to operate in the six to fifteen micron region.

DEVICE DESCRIPTION

HRC Detector Identification	LK21T1 S/N V-3
HRC Element Identification	40371S136D10
Type of Detector	Photoconductive HgCdTe
Date of Manufacture	June, 1974
Detector Operating Temperature Range	80°K to 120°K
Field of View	90°
Element Active Area Length	0.0048 Inches
Element Active Area Width	0.0049 Inches
Detector Resistance at Room Temperature	14.6 Ohms
Optimum Bias Current	4.0 Ma

DATA SUMMARY

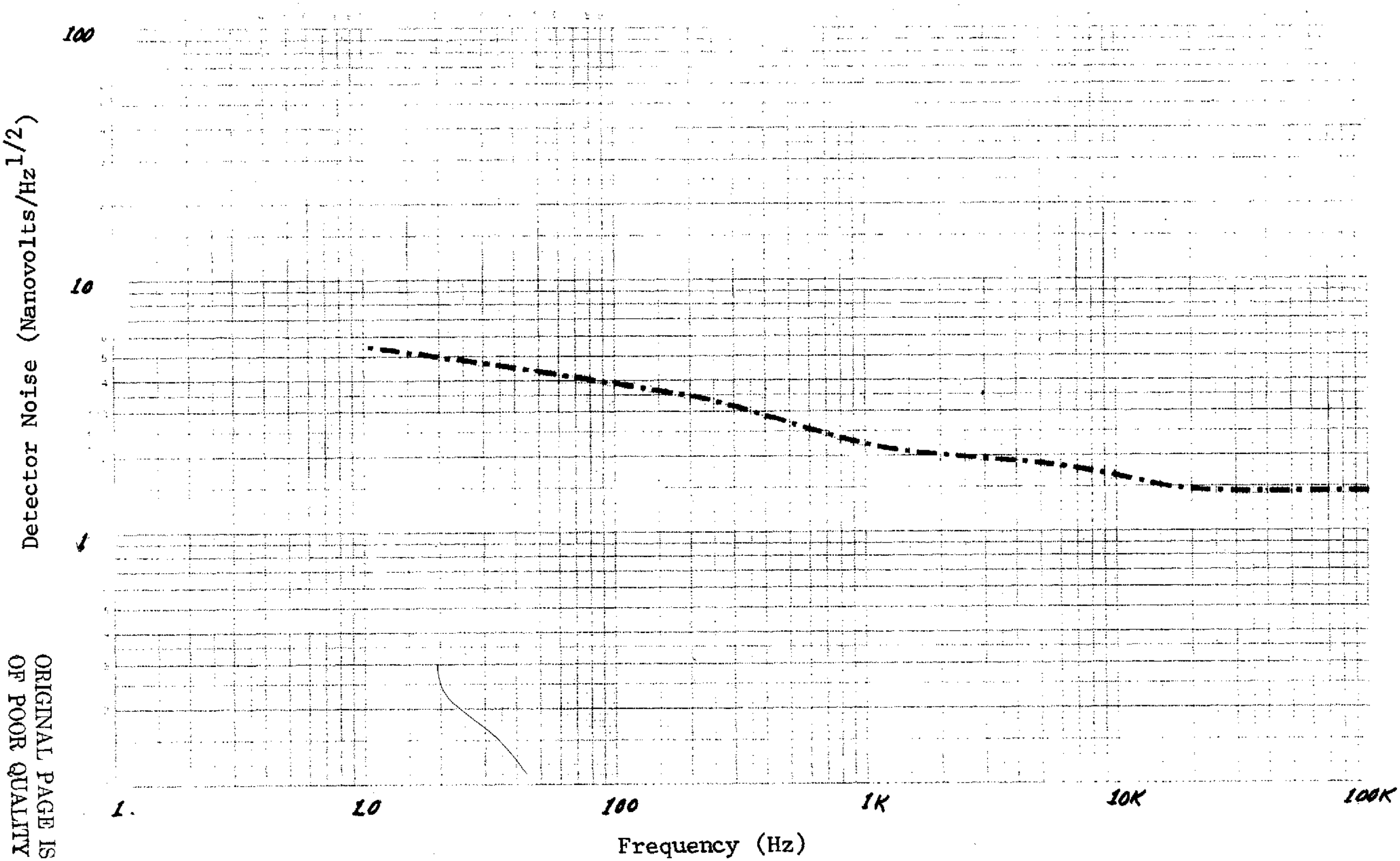
Temp. (Kv)	Noise Freq. (Hz)	Signal[1] (mv)	Noise[1] (mv)	Ampl. Gain $x10^3$	$D^*_{6.7\mu}$ $x10^{10}$	$D^*_{8.0\mu}$ $x10^{10}$	$D^*_{11.0\mu}$ $x10^{10}$	$D^*_{14.0\mu}$ $x10^{10}$	$D^*_{14.95\mu}$ $x10^{10}$	λ_p (microns)	$R_{\lambda p}$ (volts/watt)	R_{MIN} (volts/watt)	$R_{6.7}/R_{\lambda p}$	Bias Current (ma)	Volt. Drop (mv)	Power (mw)
95	2K	2.10	.031	4.70	1.00	1.20	1.53	1.12	.995	11.0	3760	2250	60%	4	137	.55
100	2K	1.65	.026	4.70	.958	1.12	1.29	1.09	.905	11.0	2950	1850	63%	4	132	.53
105	2K	1.28	.025	4.70	.726	.892	1.17	.794	.632	11.0	2310	1247	54%	4	128	.51
95	750	2.10	.038	4.70	.816	.979	1.25	.914	.812							
100	750	1.65	.032	4.70	.778	.910	1.05	.886	.735							
105	750	1.28	.030	4.70	.605	.743	.975	.662	.527							

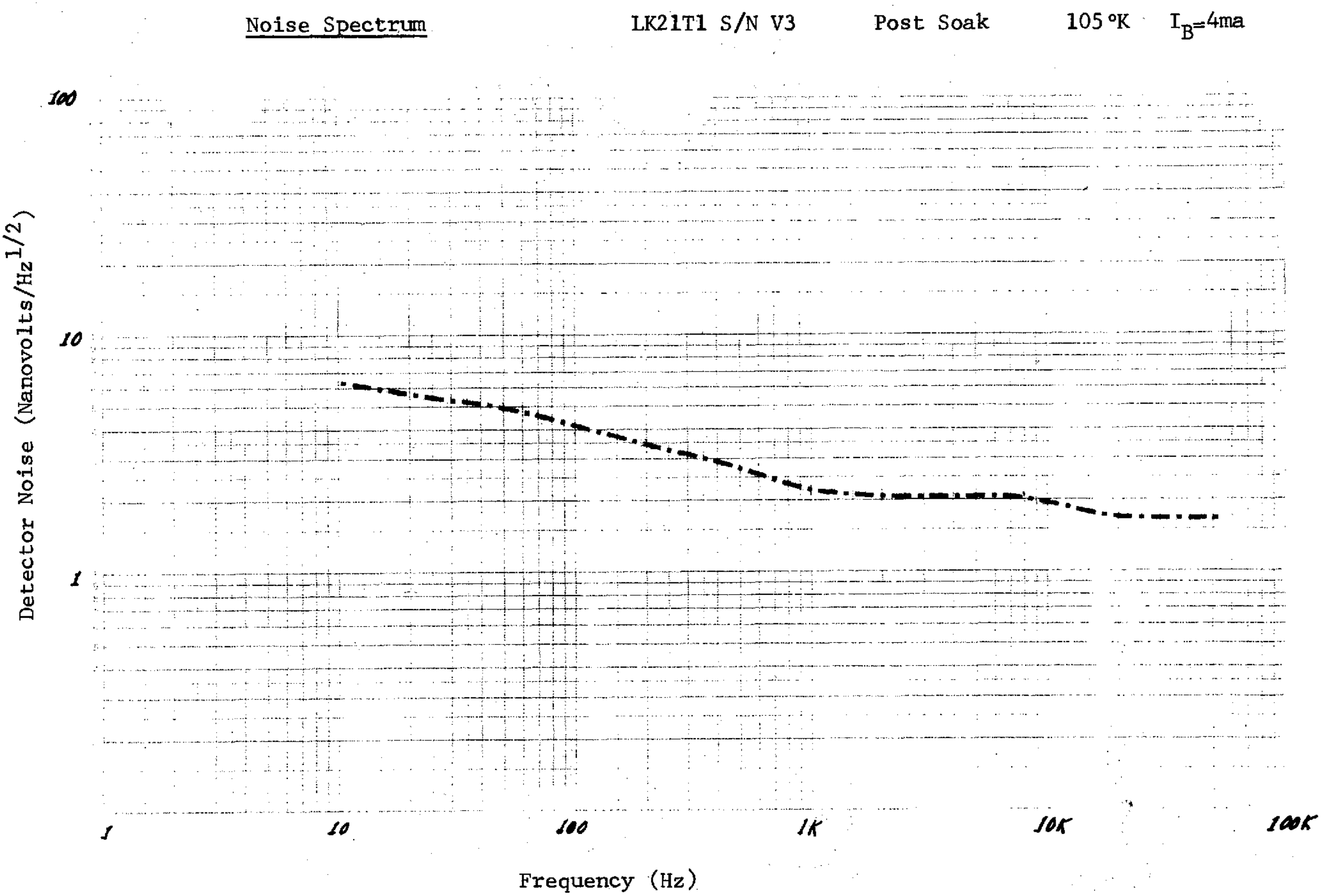
[1] Actual measurements made at Amplifier Output with 6 Hz bandwidth Wave Analyzer

D^*_λ (λ, Hz, 1, 90°) in $CmHz^{1/2}w^{-1}$

Noise Spectrum

LK21T1 S/N V3 Pre Soak 105 °K I_B=4ma



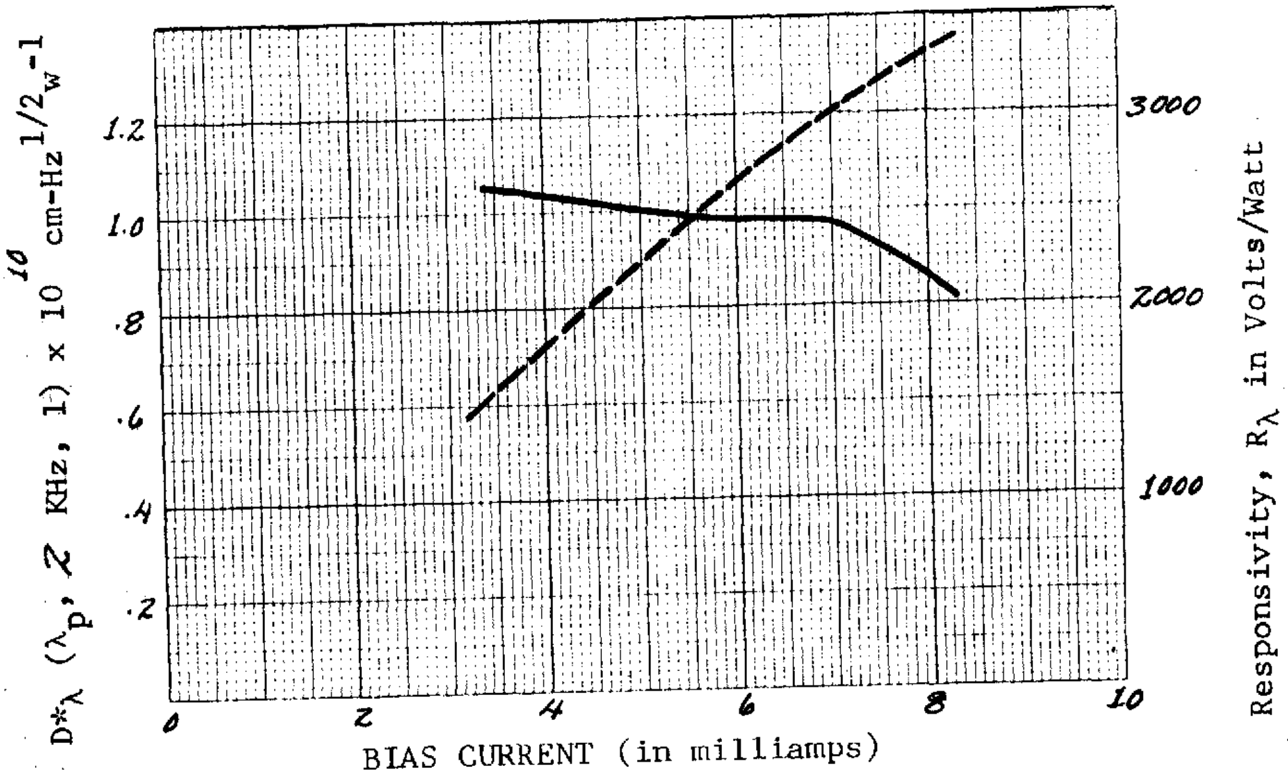

Noise Spectrum
LK21T1 S/N V3
Post Soak
105 °K
I_B=4ma
100
10
1
Detector Noise (Nanovolts/$Hz^{1/2}$)
1
10
100
1K
10K
100K
Frequency (Hz)

PRE SOAK

LK 21T1 S/N V3

TEMP. = 105°K

D*$_\lambda$ vs Bias, Responsivity (R_λ) vs Bias

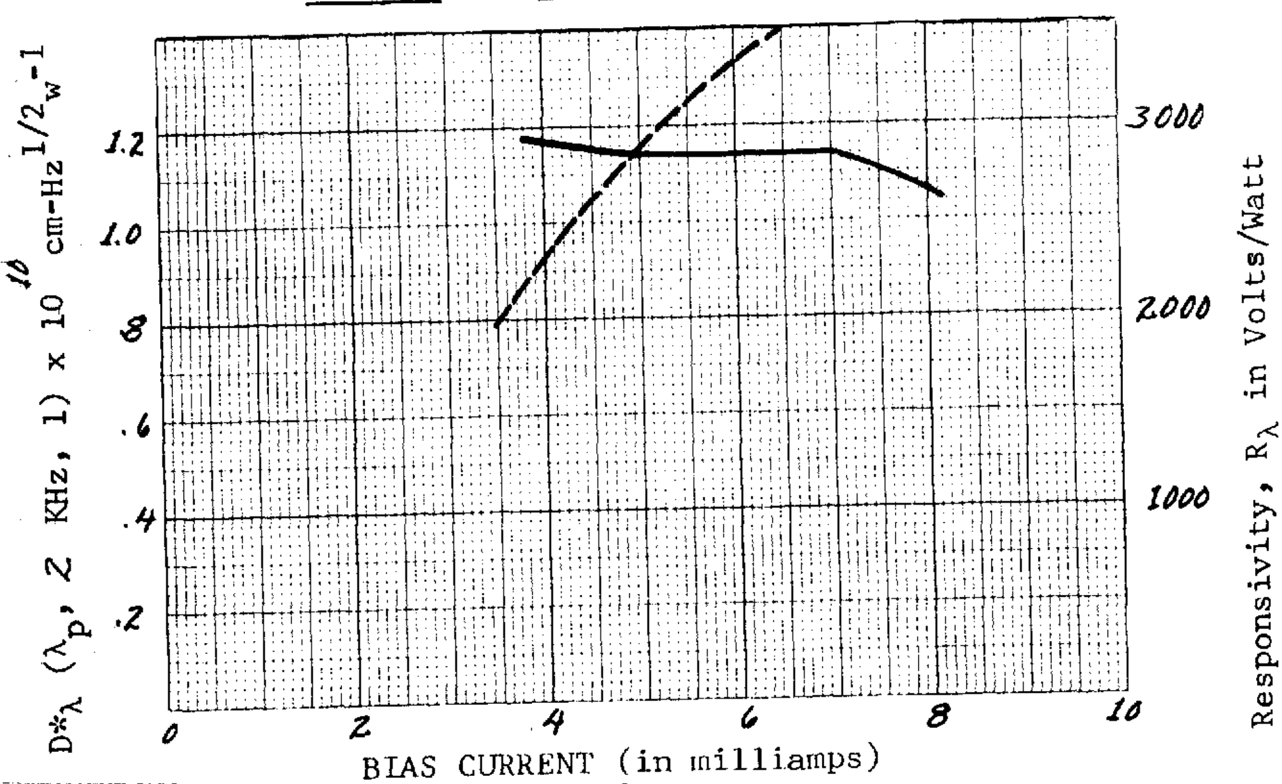


POST SOAK

LK 21T1 S/N V3

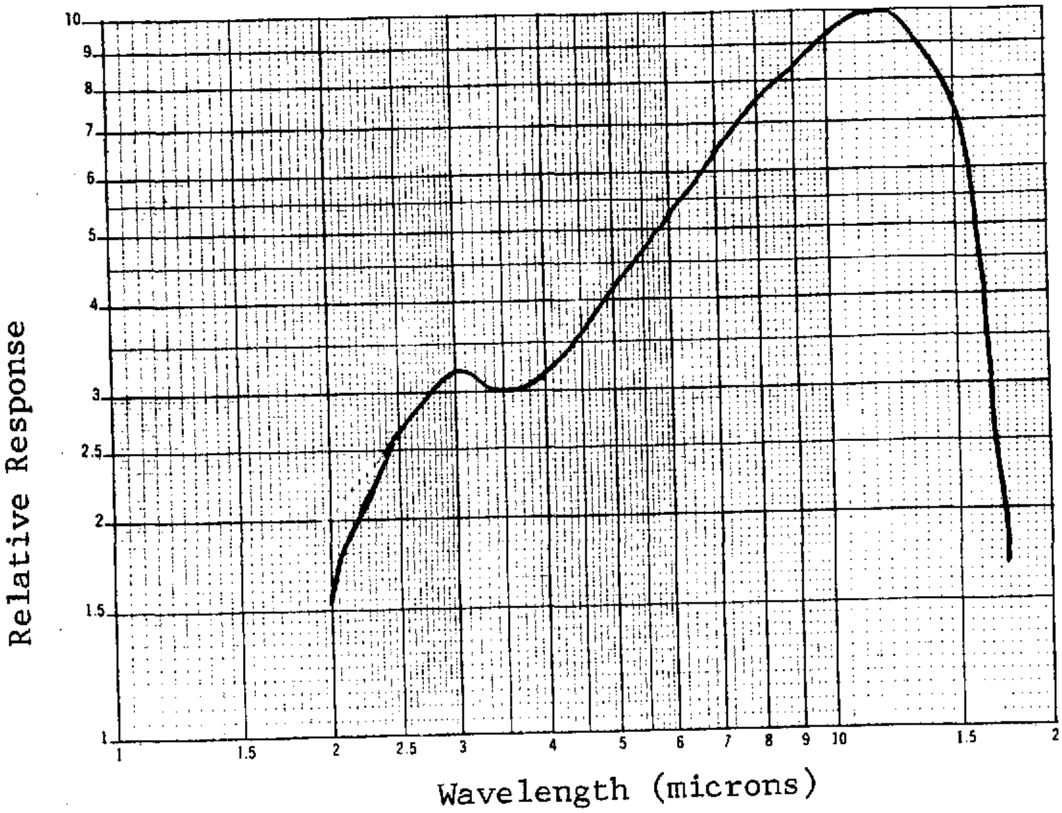
Temp. = 105°K

D*$_\lambda$ vs Bias, Responsivity (R_λ) vs Bias

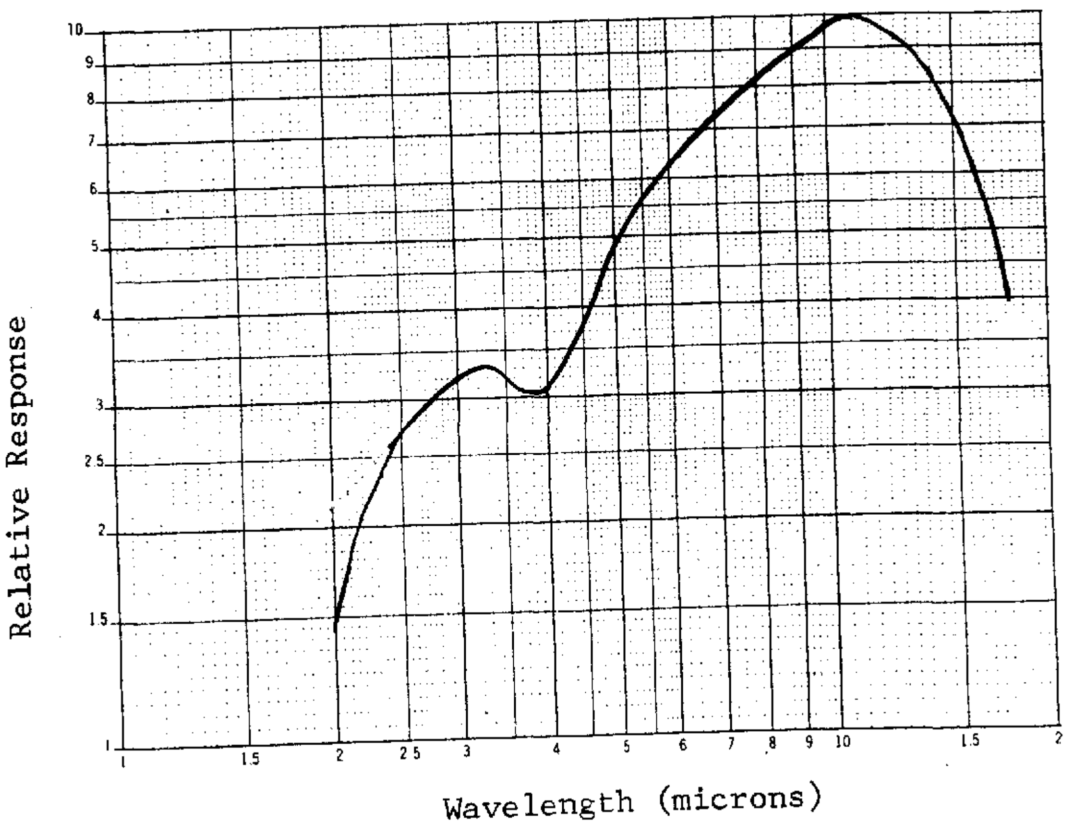


Relative Spectral Response

Pre Soak Temperature 80°K

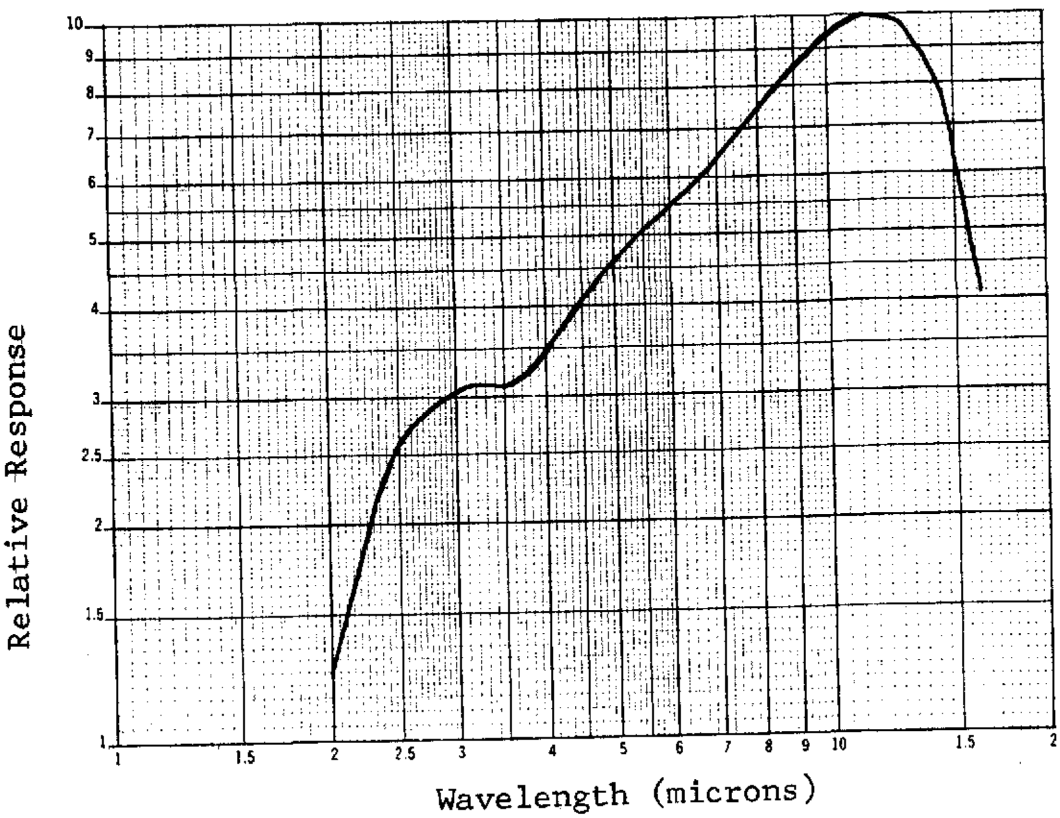


Post Soak

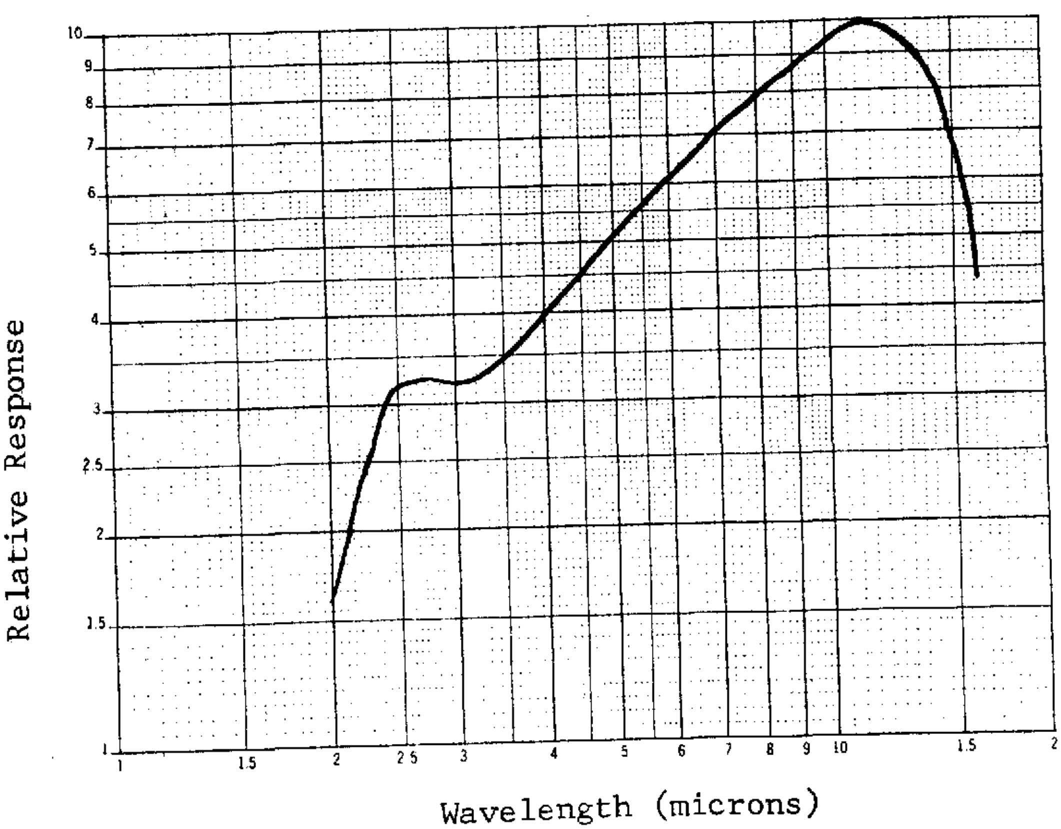


Relative Spectral Response

Pre Soak Temperature 85 °K

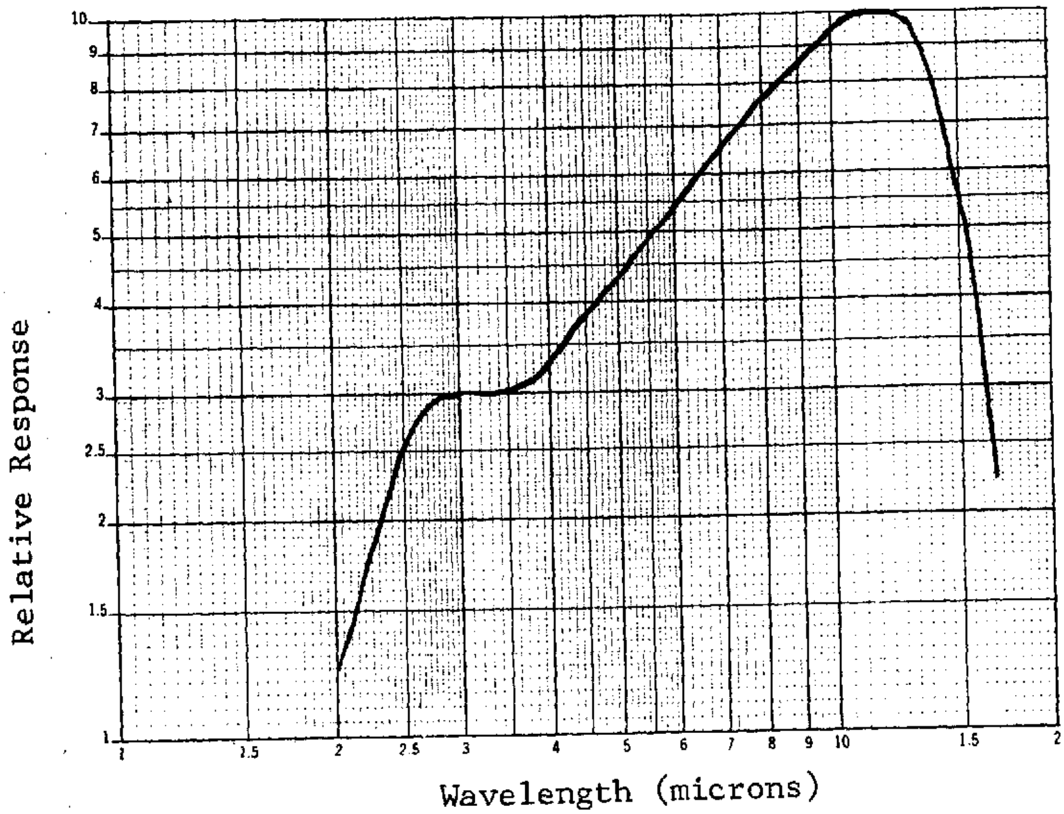


Post Soak

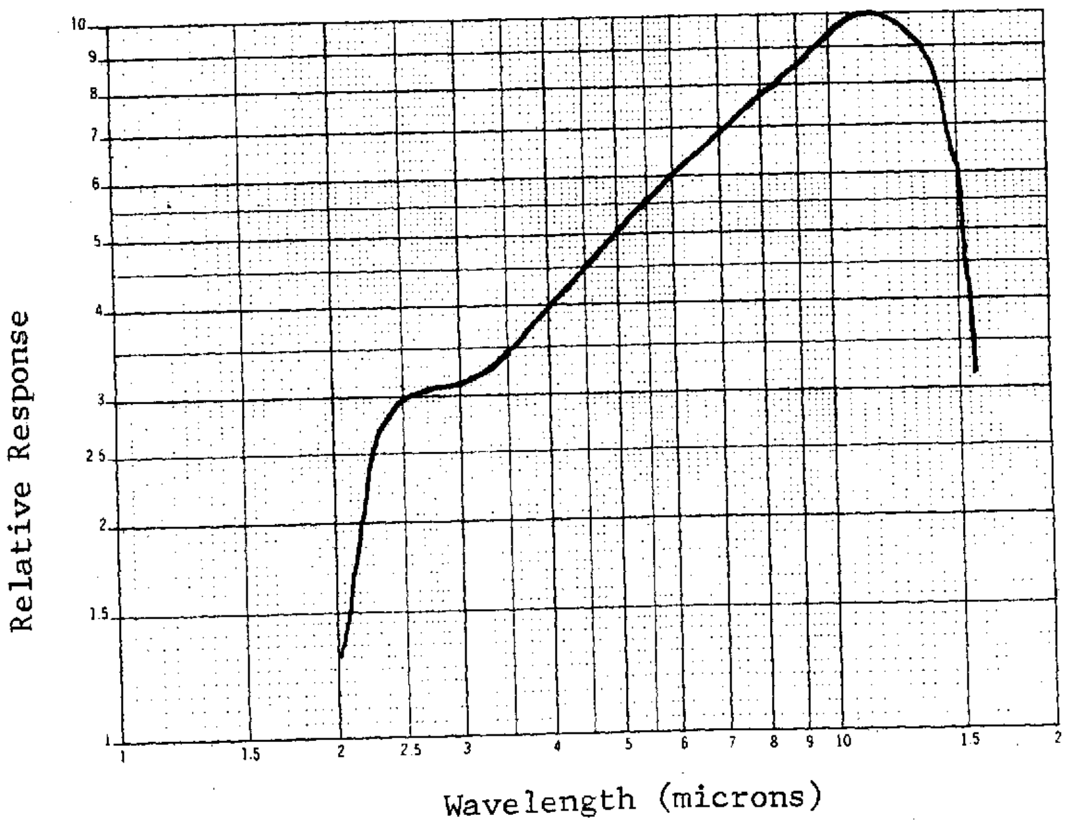


Relative Spectral Response

Pre Soak Temperature 90 °K

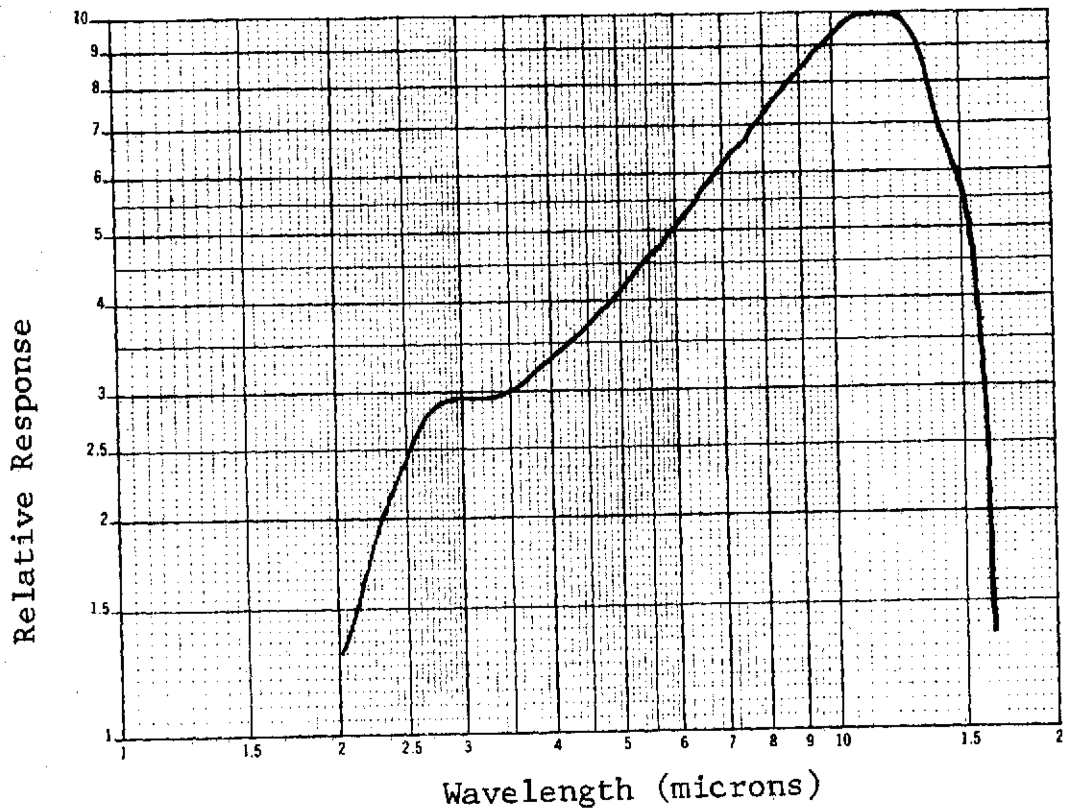


Post Soak

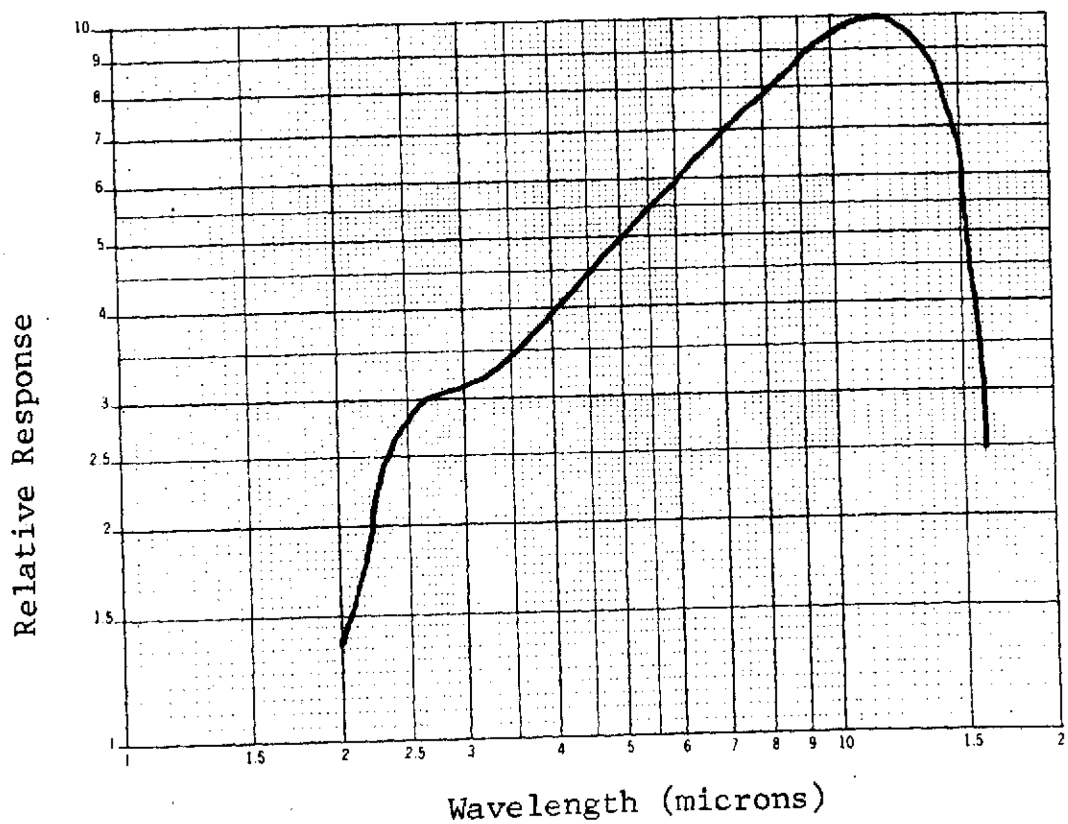


Relative Spectral Response

Pre Soak Temperature 95°K

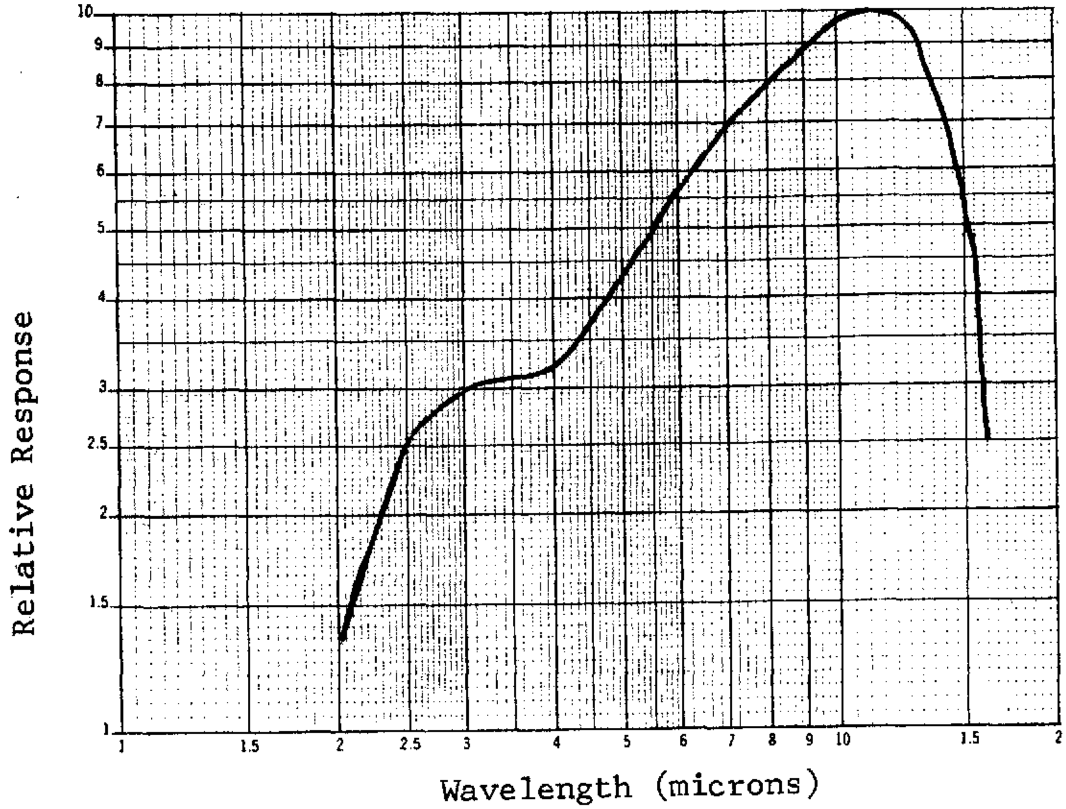


Post Soak

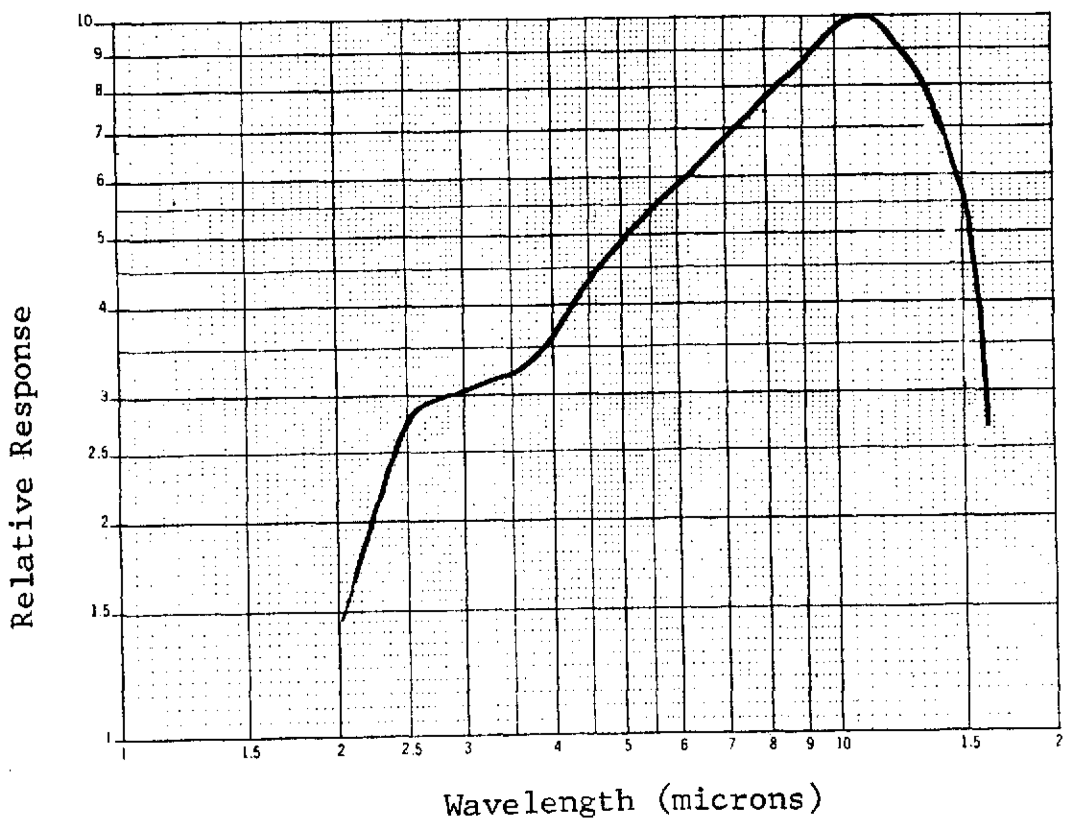


Relative Spectral Response

Pre Soak Temperature 100 °K

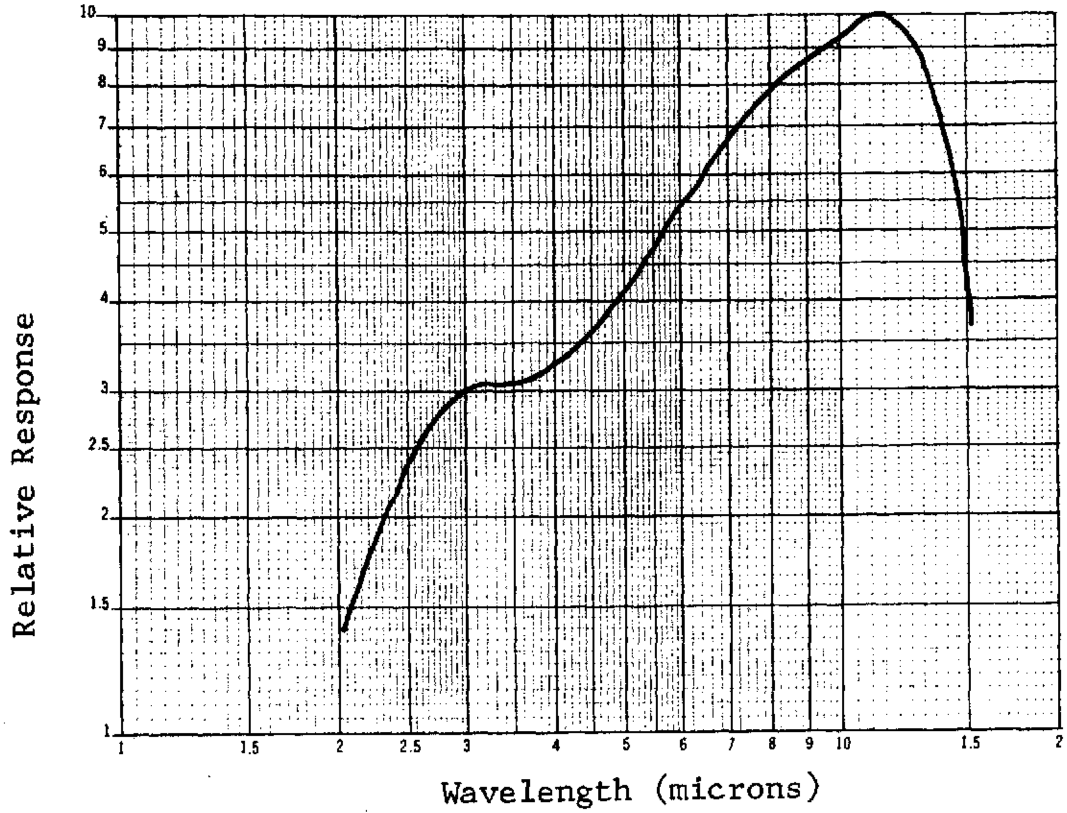


Post Soak

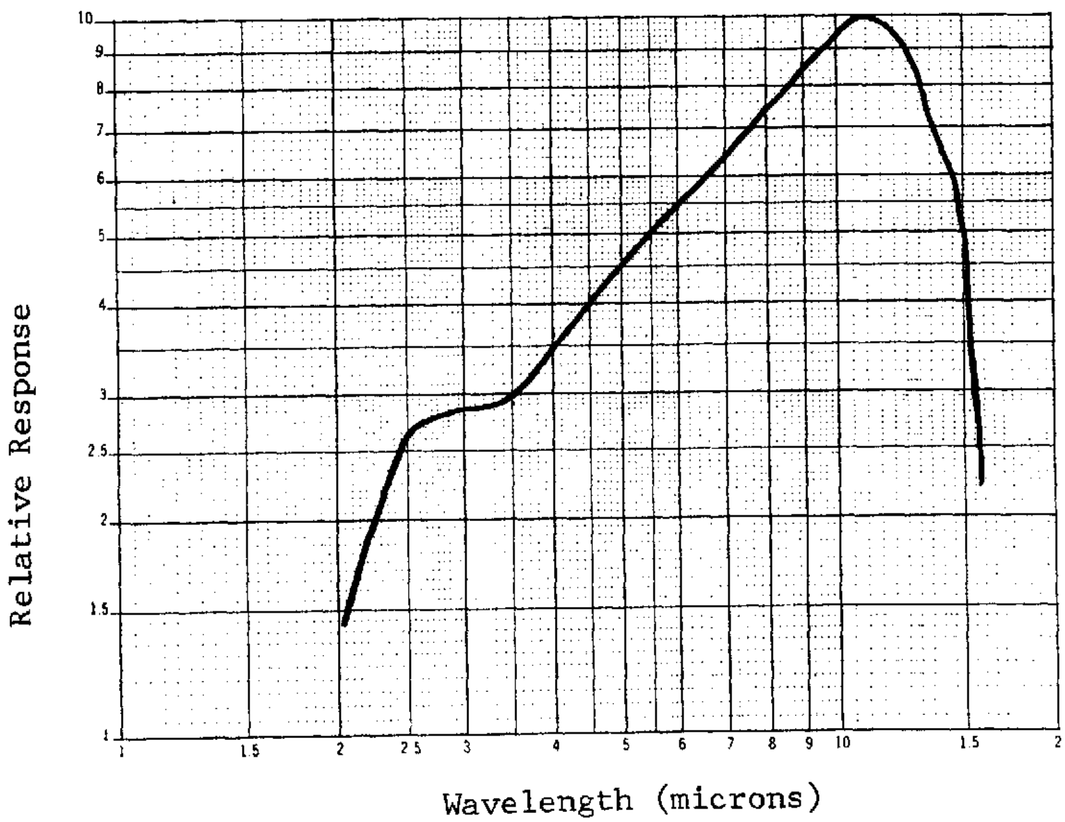


Relative Spectral Response

Pre Soak Temperature 105 °K



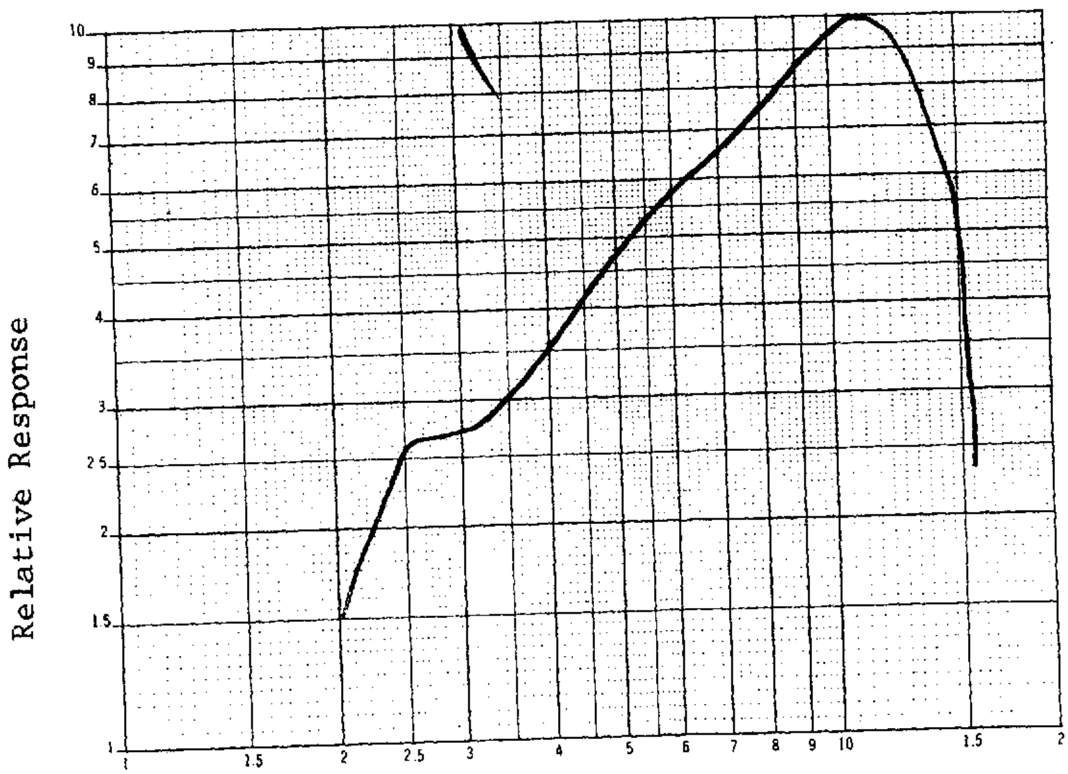
Post Soak



Relative Spectral Response

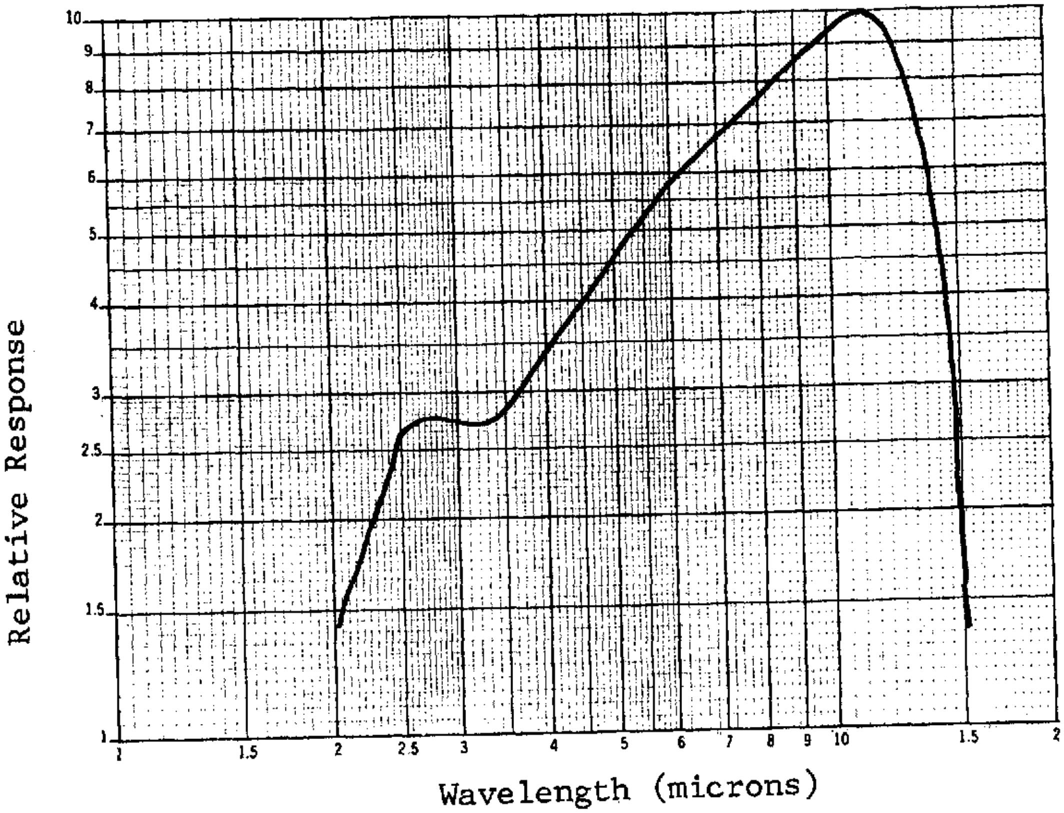
Pre Soak Temperature 110 °K

Post Soak

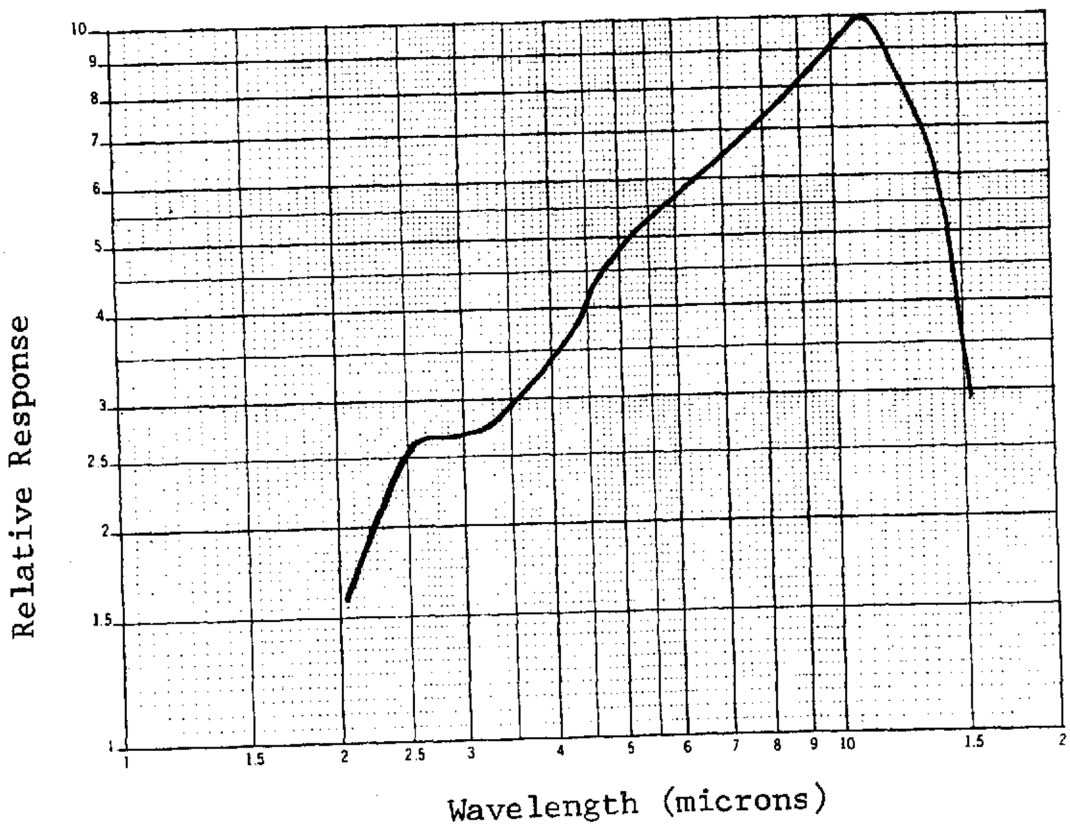


Relative Spectral Response

Pre Soak Temperature 115°K

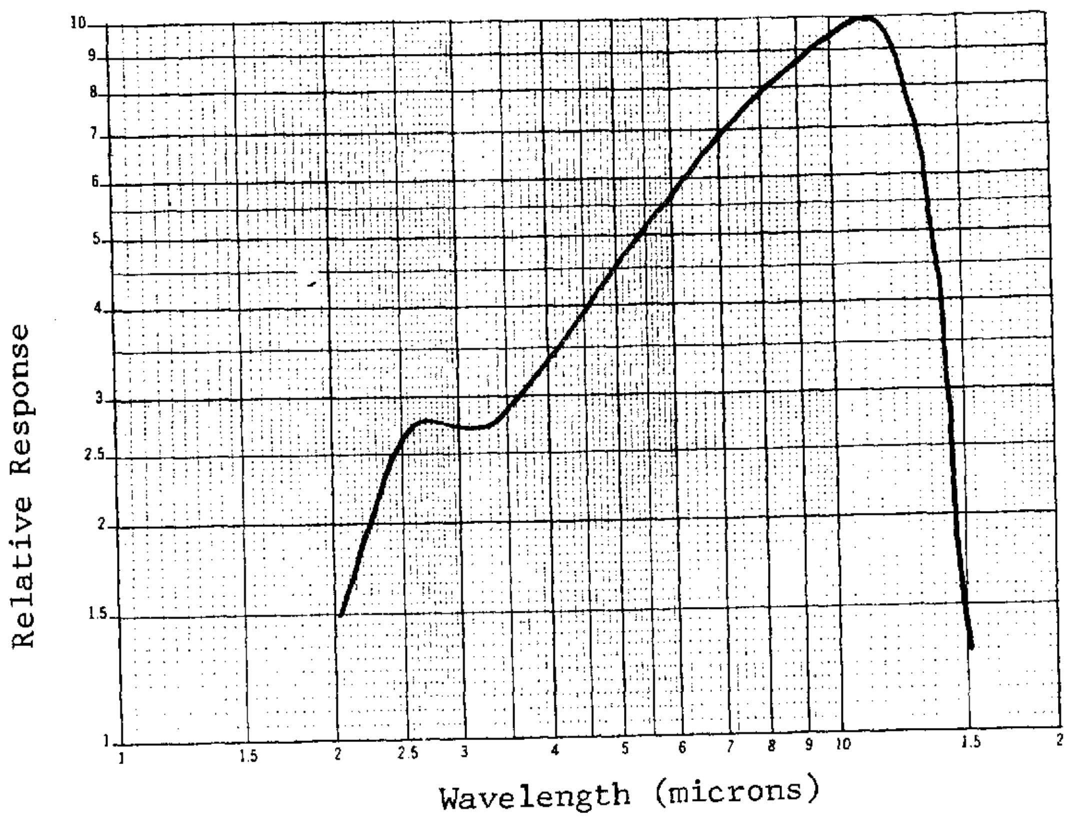


Post Soak

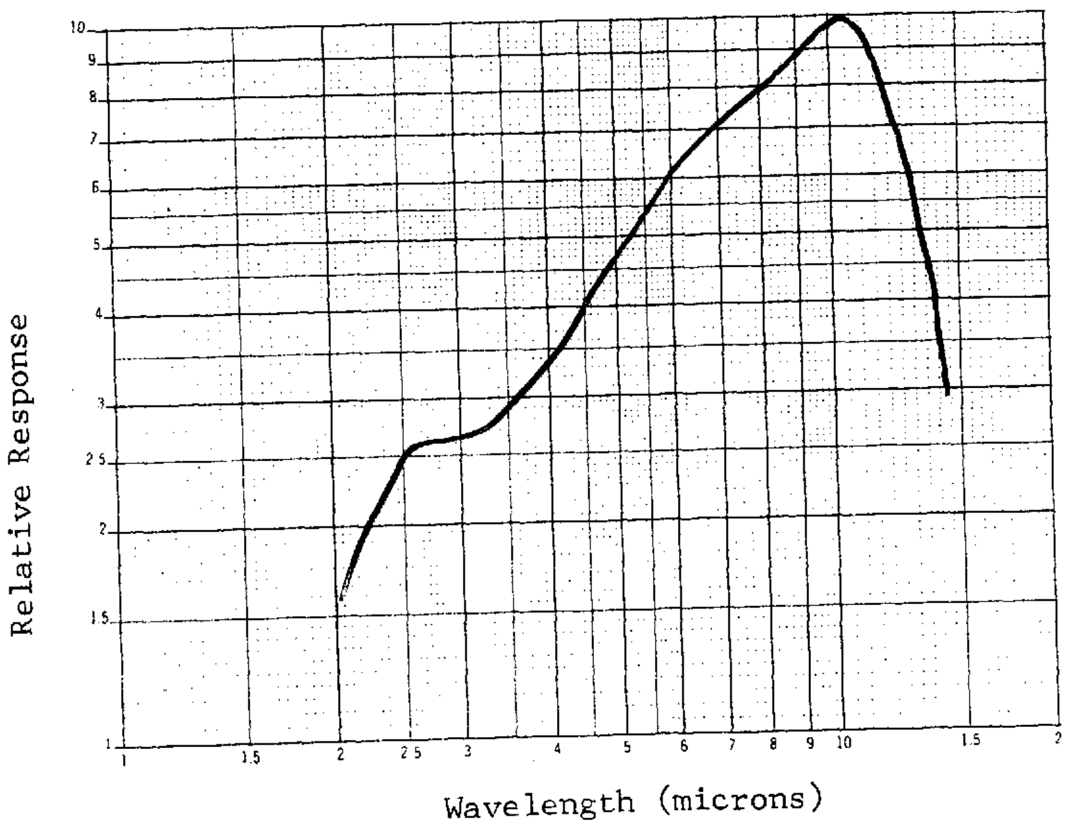


Relative Spectral Response

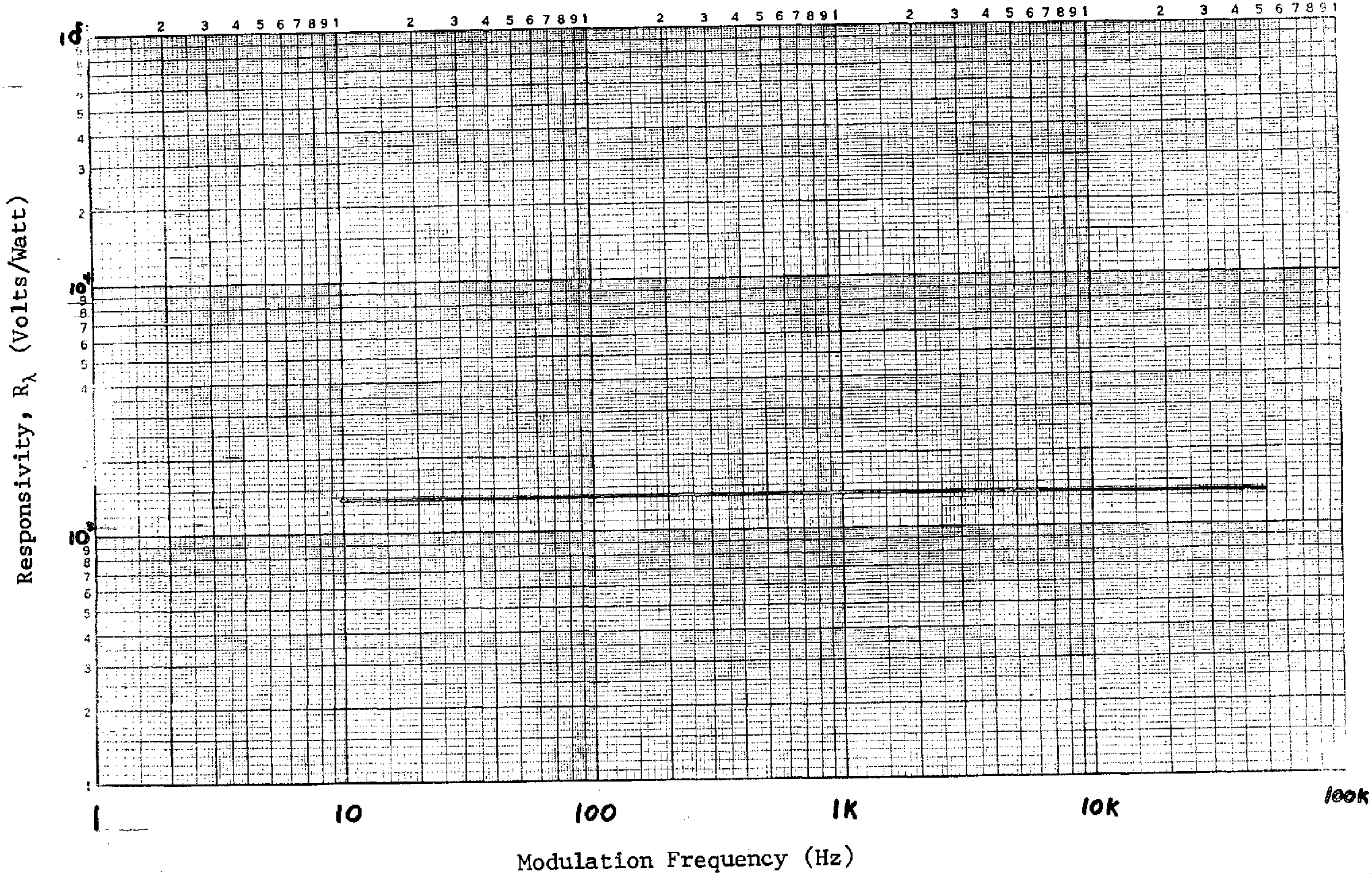
Pre Soak Temperature 120 °K



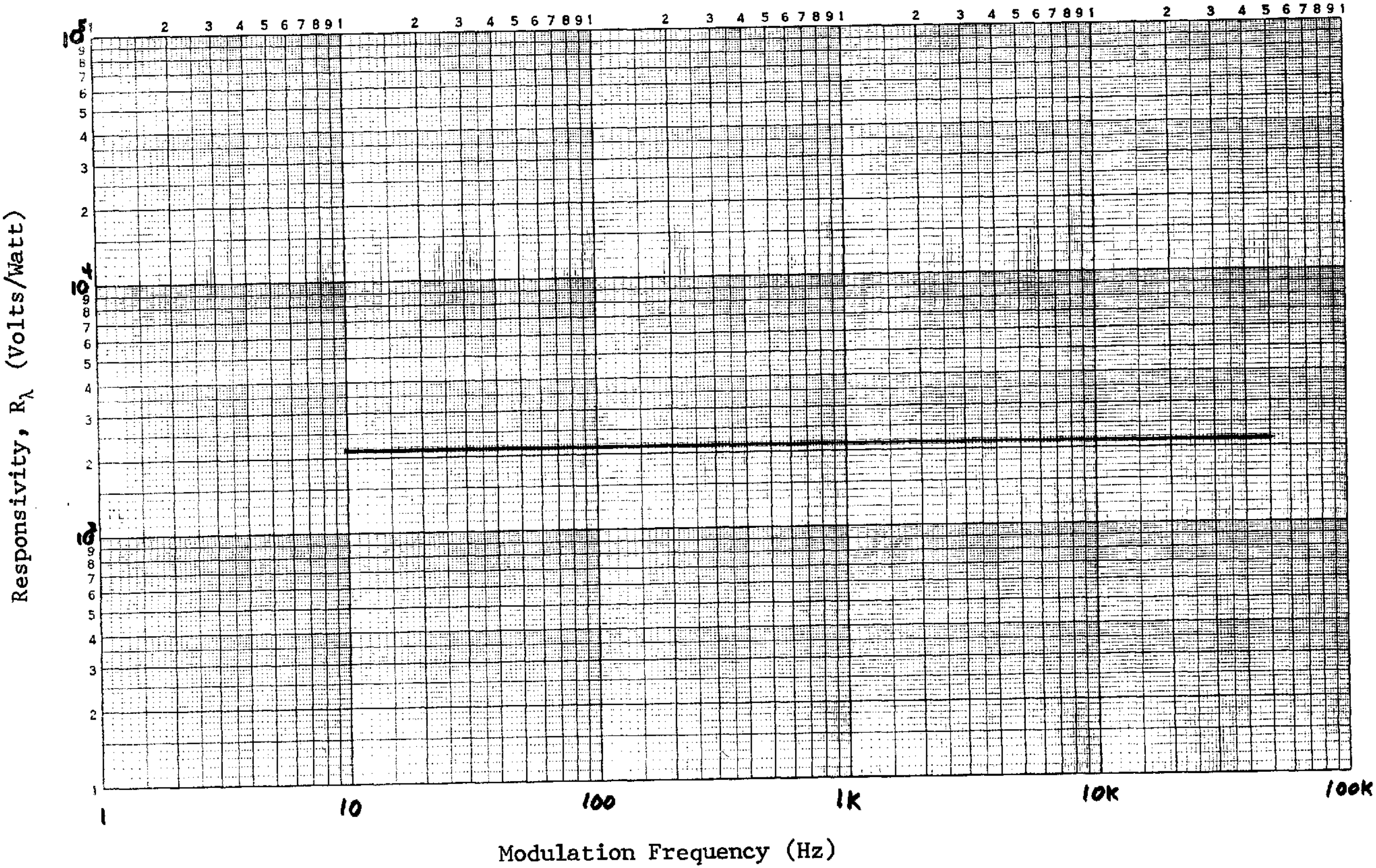
Post Soak

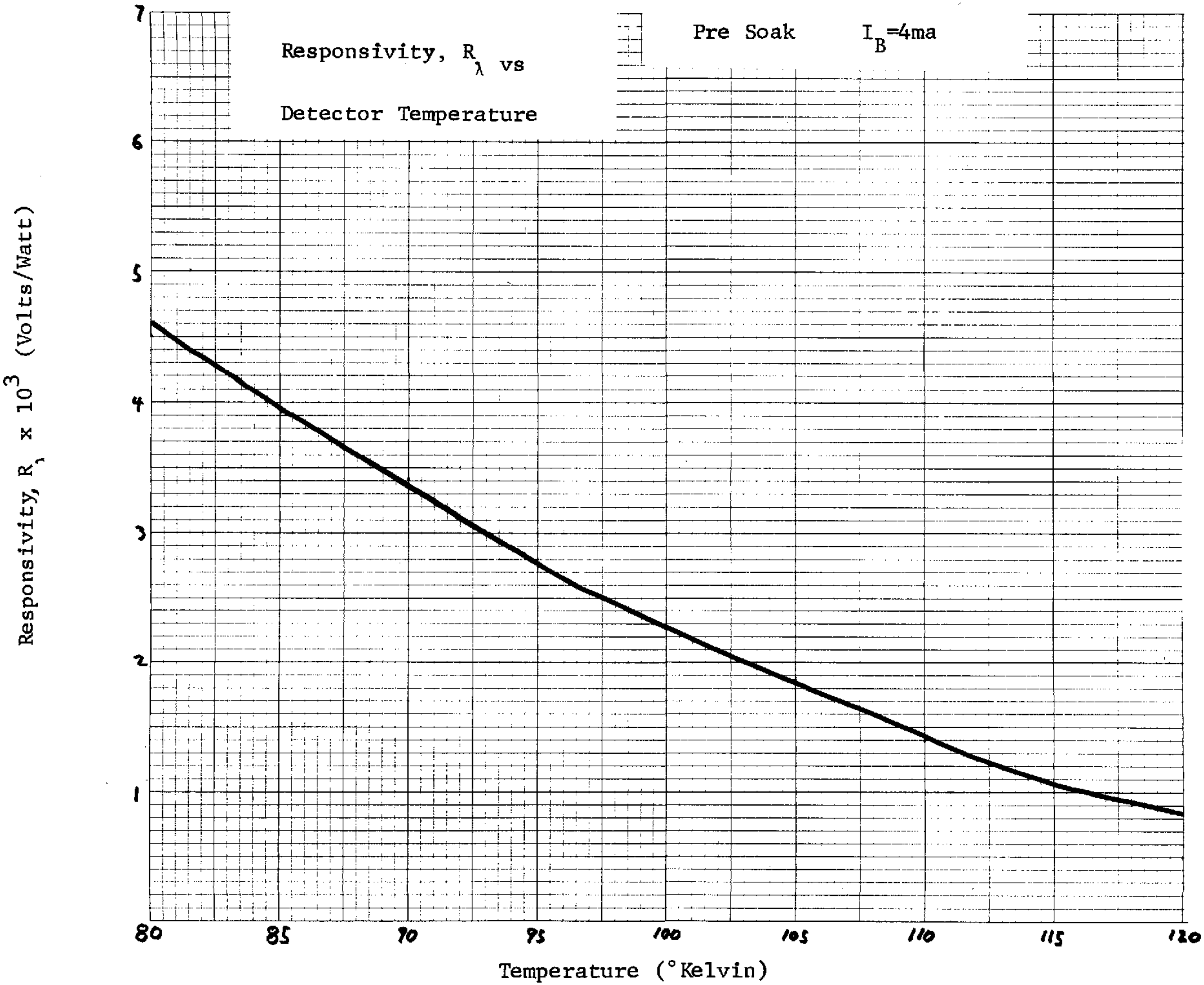


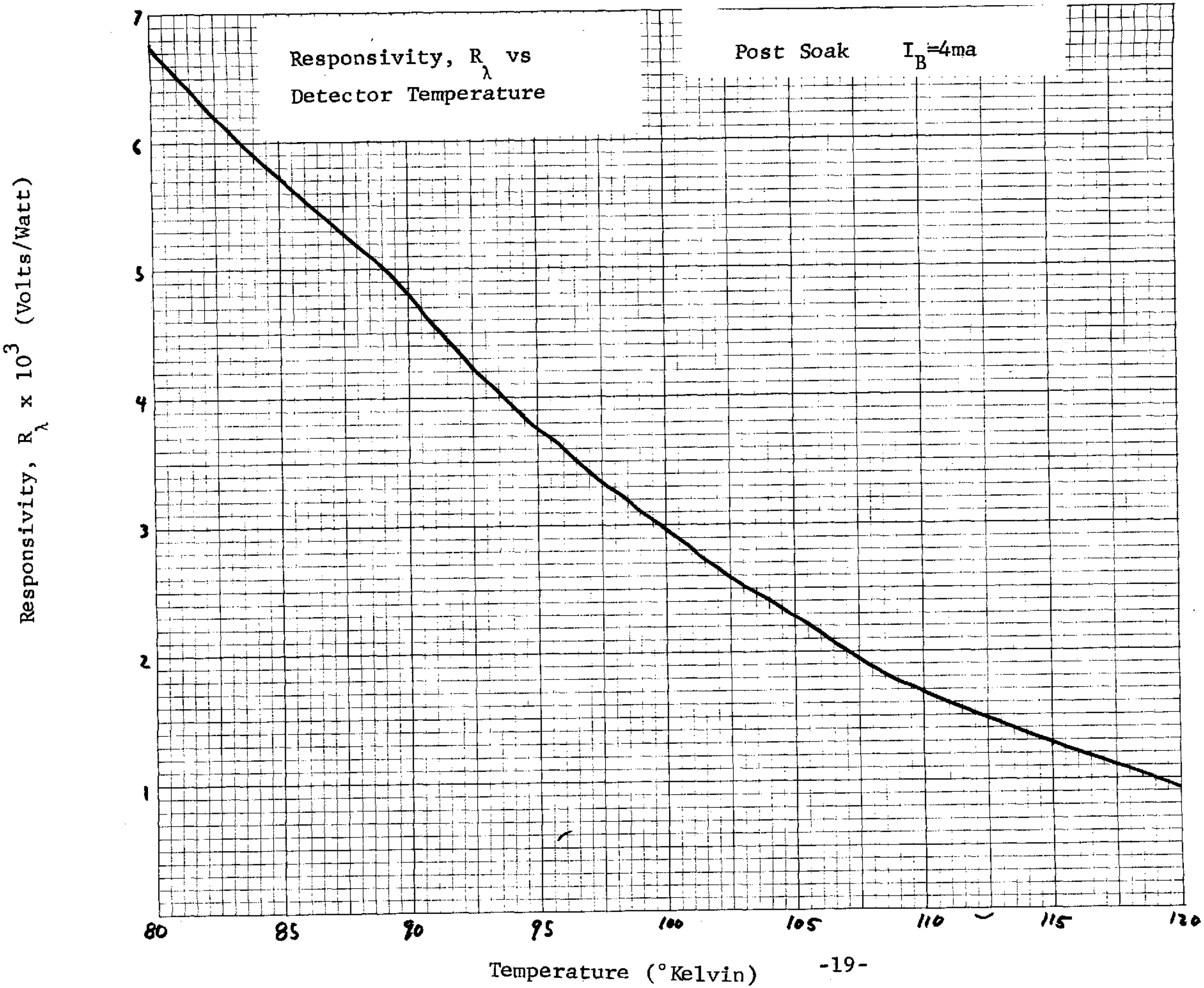
Responsivity vs Modulation Frequency Pre Soak 105 °K I_B=4ma



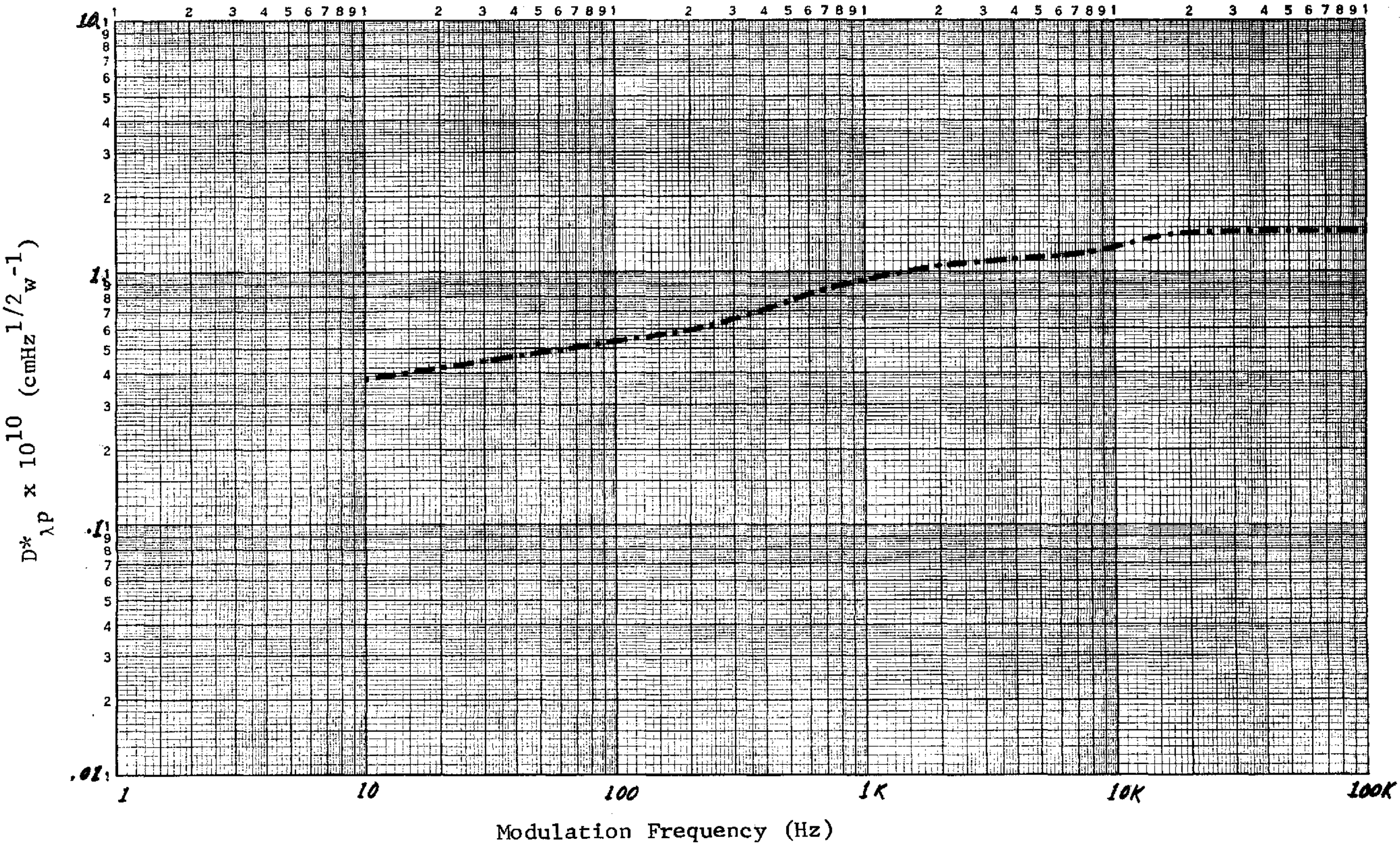
Responsivity vs Modulation Frequency   Post Soak   105 °K I_B=4ma



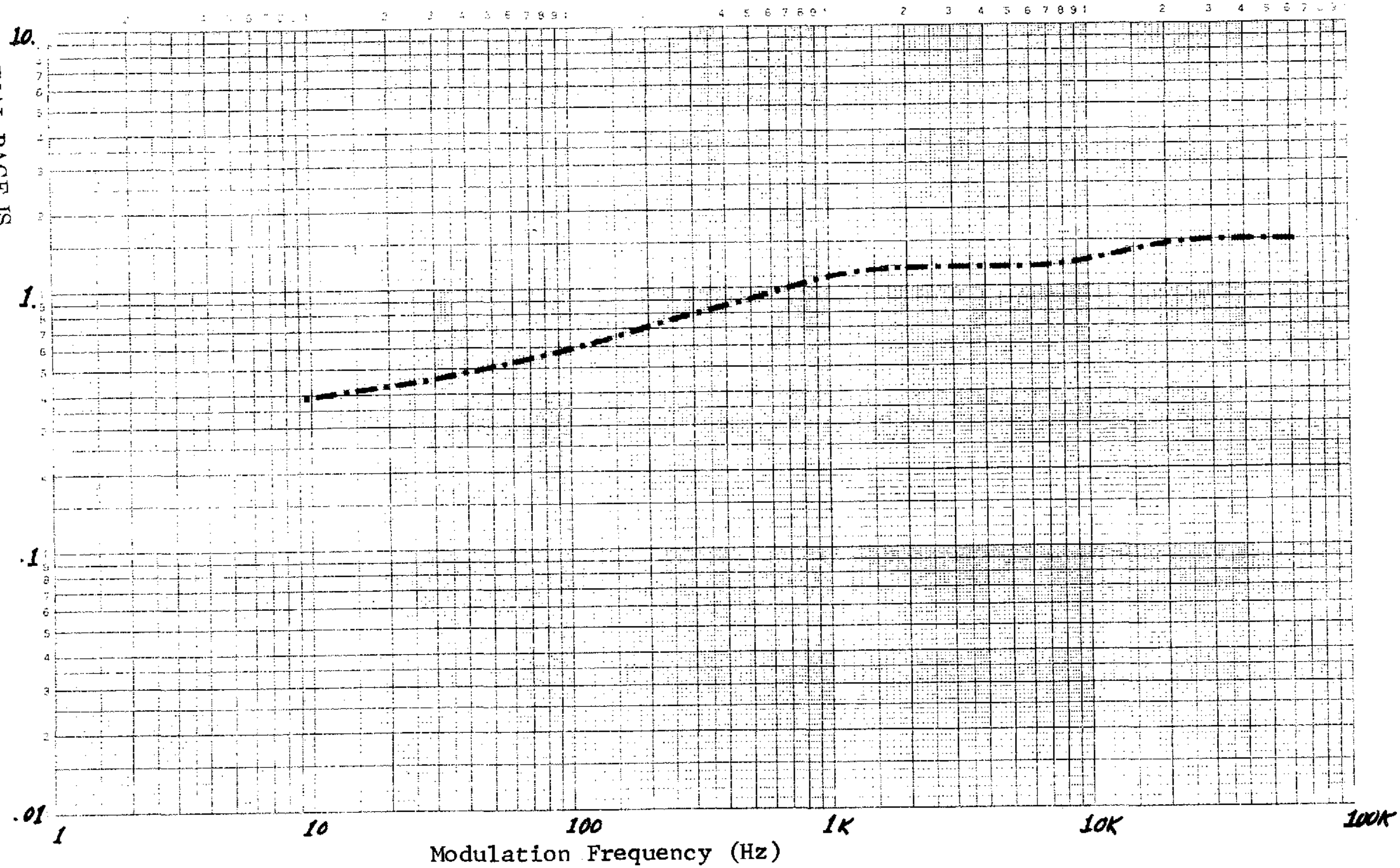

Responsivity, R_λ vs
Detector Temperature
Pre Soak I_B=4ma
Responsivity, R_λ x 10^3 (Volts/Watt)
1
2
3
4
5
6
7
80
85
90
95
100
105
110
115
120
Temperature (°Kelvin)


Responsivity, R_λ vs
Detector Temperature
Post Soak I_B=4ma
Responsivity, $R_\lambda \times 10^3$ (Volts/Watt)
7
6
5
4
3
2
1
80
85
90
95
100
105
110
115
120
Temperature (°Kelvin)

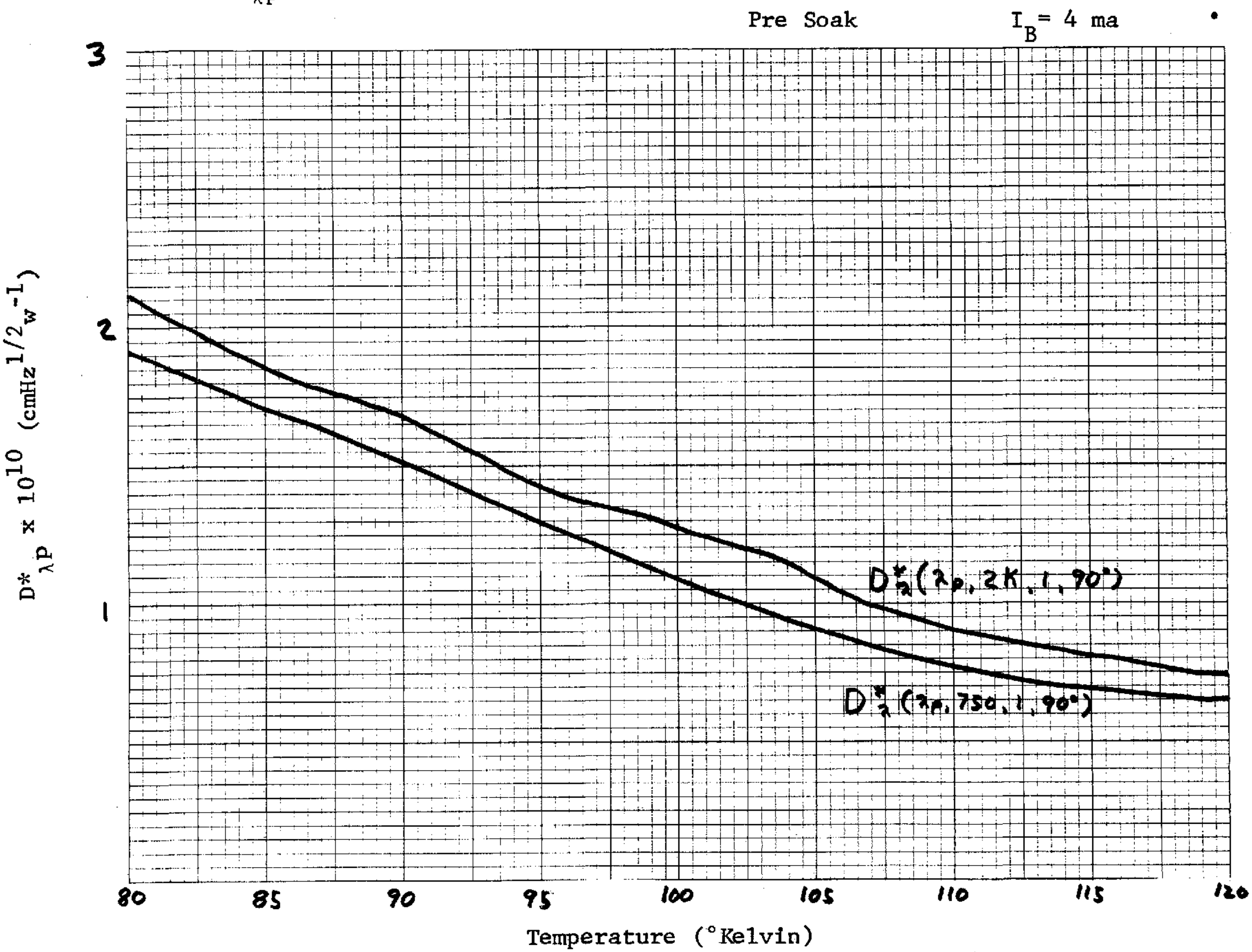
$D^*_{\lambda p}$ vs Modulation Frequency Pre Soak 105°K I_B=4ma



$D^*_{\lambda p}$ vs Modulation Frequency   Post Soak   105°K I_B=4ma

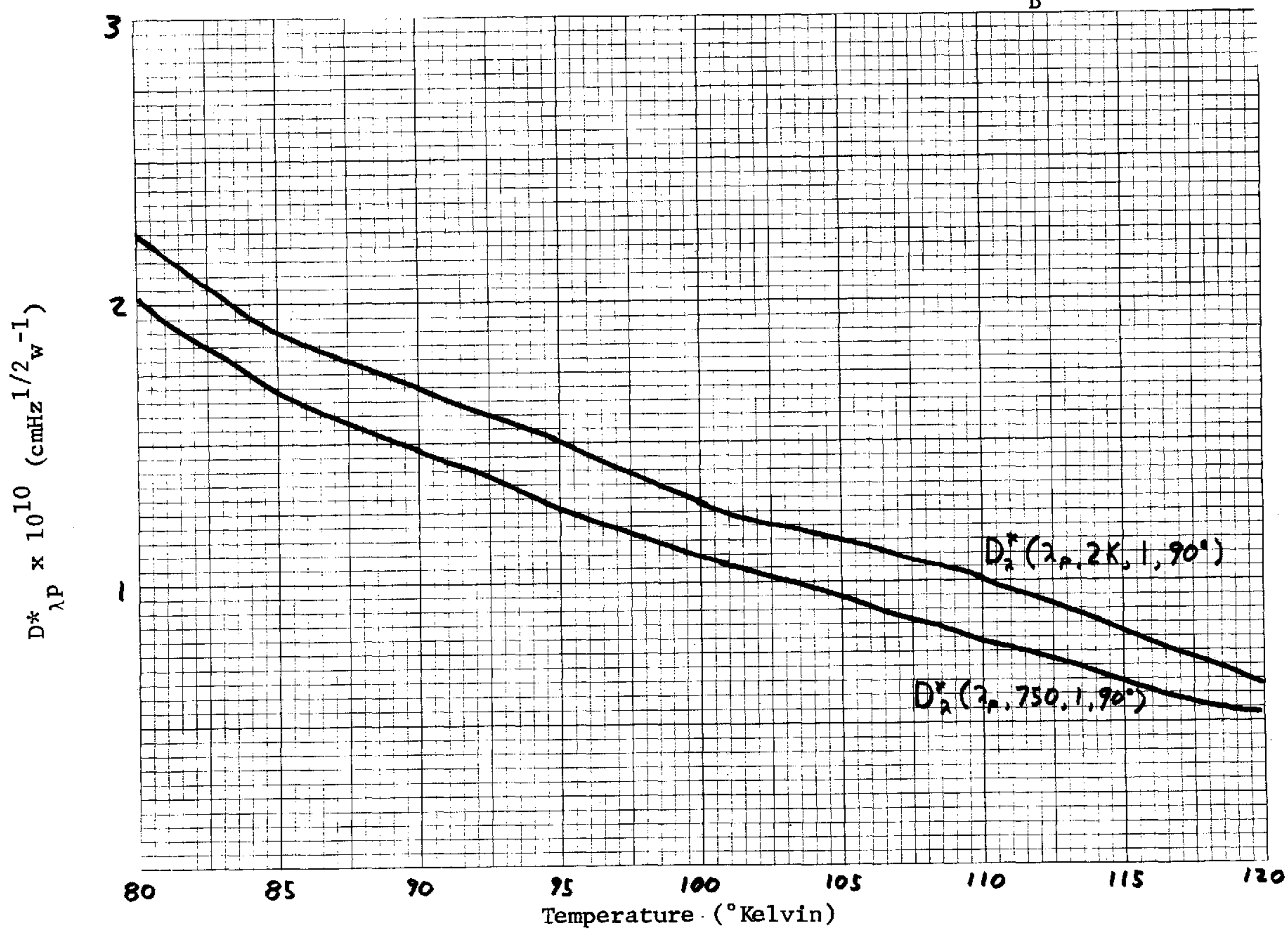


$D^*_{\lambda P}$ vs Detector Temperature



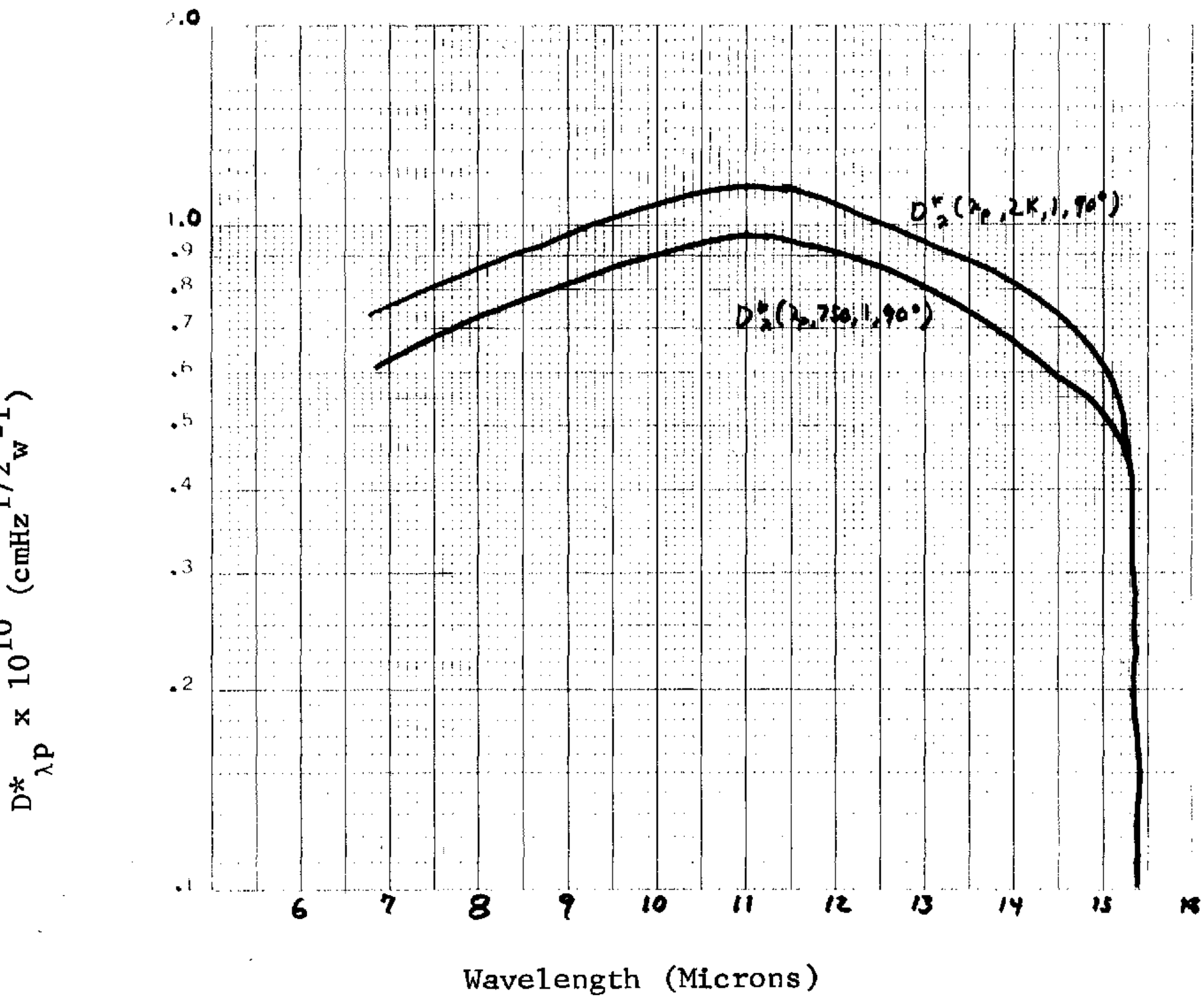
$\underline{D^*_{\lambda P} \text{ vs Detector Temperature}}$

Post Soak $I_B = 4$ ma



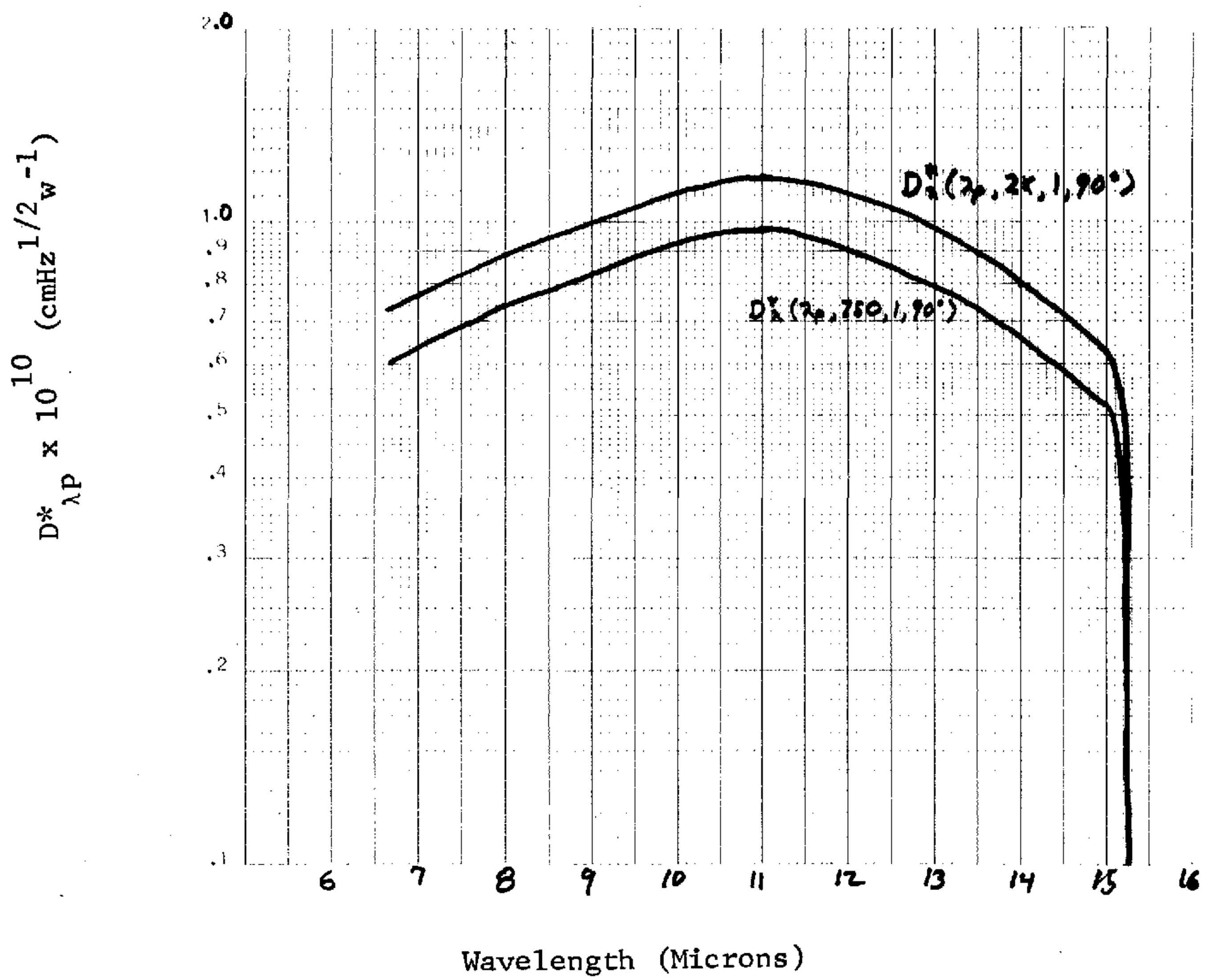
$D^*_{\lambda p}$ vs Wavelength

Pre Soak 105°k $I_B = 4$ ma



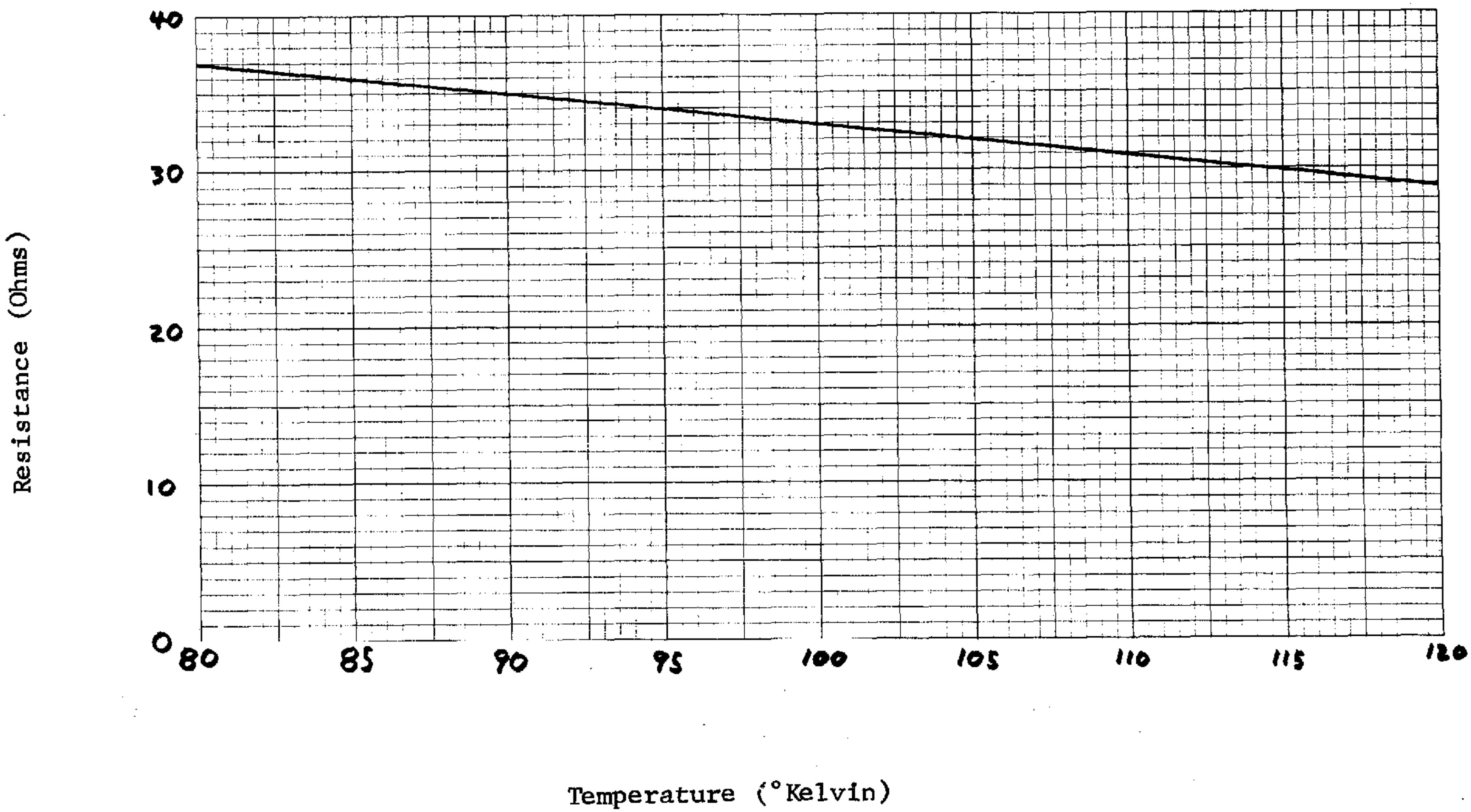
$D^*_{\lambda P}$ vs Wavelength

Post Soak 105°K I_B= 4 ma



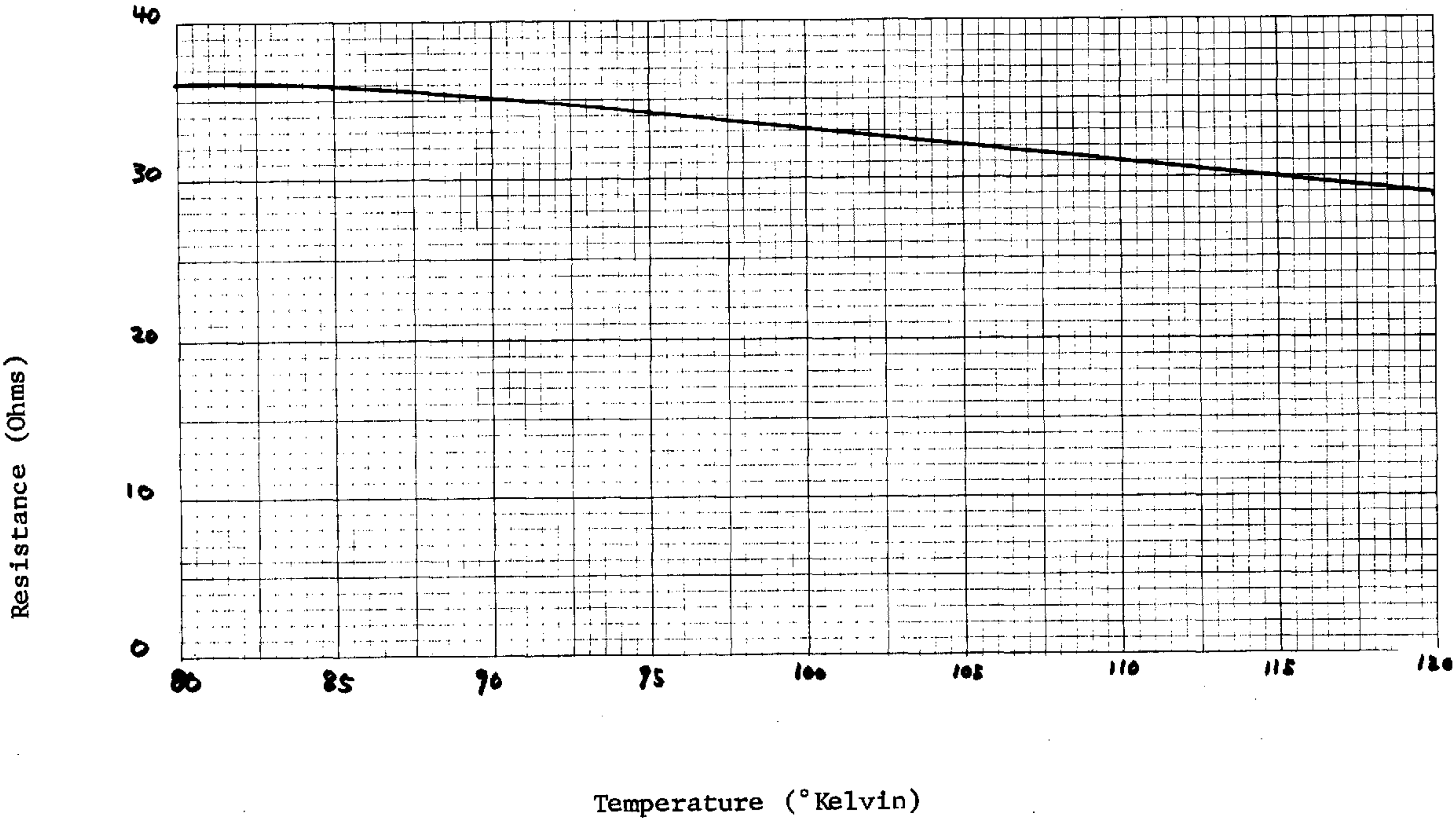
Detector Resistance vs Temperature

Pre Soak $I_B = 4$ ma



Detector Resistance vs Temperature

Post Soak $I_B = 4$ ma



DETECTOR TEST DESCRIPTION

LIST OF TEST EQUIPMENT

The following equipment or its equivalent was used to test the detector electrical characteristics:

1. Blackbody source - IRI Model 403
2. Blackbody temperature controller - IRI Model ISL 101R
3. Wave analyzer - HP Model 302A
4. Integrating VTVM - IRI Model 602A
5. Oscilloscope - HP type 547
6. Preamplifier and battery bias supply - HRC design
7. 1 KHz sine wave chopper - HRC design
8. Spectrometer - Perkin Elmer Model 112
9. Variable temperature dewar - HRC design

Calculation of D^*_{bb}

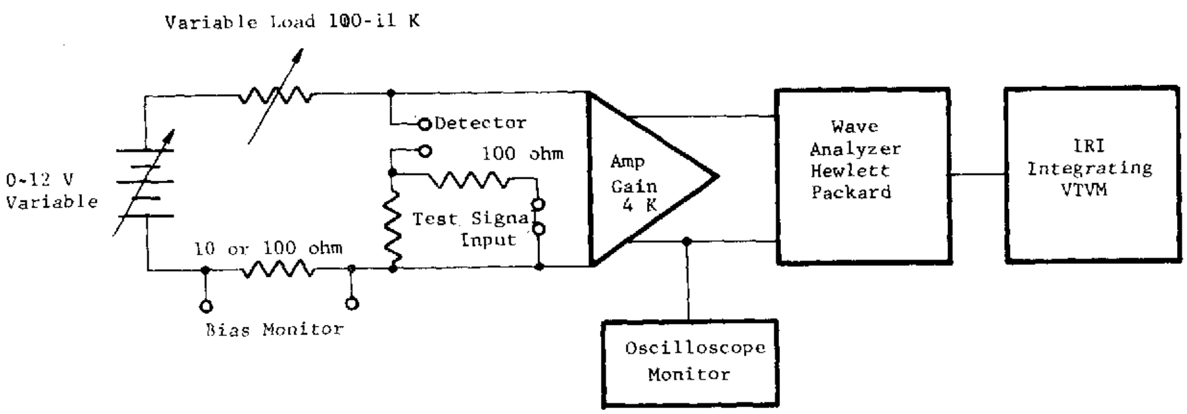
Detector Temperature	77 °K
Chopping Frequency	1,000 Hz
Detector Area (A_D)	See Test No. 4
Orifice Diameter (d_B)	0.050 inch
Blackbody Temperature (T_B)	500 °K
Background Temperature (T_c)	300 °K
Emissivity	
Blackbody (ϵ_B)	1.0
Chopper (ϵ_C)	1.0
Noise Bandwidth (Δf)	6 Hz
Chopper RMS Factor (K_1)	0.35
Detector to Orifice Distance (D)	15 cm
Stefan-Boltzman Constant (K_2)	5.67×10^{-12}
RMS Noise Correction (K_3)	1.12
Amplifier Gain (same for signal & noise)	$\approx$ 4,000

D* Formula:

$$D^*_{BB} = \frac{4 D^2 (\Delta f)^{1/2}}{K_1 \; K_2 \; K_3 \; d_B^2 \qquad (\epsilon_B \; T_B^4 - \epsilon_C \; T_c^4)} \times \frac{S}{N\sqrt{A_D}}$$

$$Resp_{BB} = \frac{4D^2}{K_1 \; K_2 \; d_B^2 \qquad (\epsilon_B \; T_B^4 - \epsilon_C \; T_c^4)} \times \frac{S}{A_D G}$$

DETECTOR READOUT CIRCUITRY



HANDLING AND PRECAUTIONS FOR HRC PRECISION INFRARED DETECTORS

This precision infrared detector was built in the laboratories of the Honeywell Radiation Center with the utmost care, using some of the most modern technology. However, as with any precision piece of equipment, there are tolerance limitations to which it can be subjected physically, thermally, and electrically.

<u>Operating Temperature</u>: The detector is designed to operate at temperatures between 80 and 120° Kelvin.

<u>Window and Housing</u>: Parts may crack or break if subjected to high impact. Always transport the detector in the container in which it was shipped.

<u>Detector Element Burnout</u>: The detector element dissipates only milliwatts of power, therefore, do not over bias it.

A. Caution: If a lead from the detector breaks contact with bias circuit:

   1. Turn off bias and amplifier power source.
   2. Discharge coupling capacitor by shorting test leads.
   3. Re-connect detector element to bias supply.
   4. Turn bias power on again.

B. When the detector is connected to any power source, there must be no voltage differential between the contacts until after the circuit is complete.

C. Do not use any amplifier circuit that may generate current surges in the detector.

D. The detector should be operated only in a cooled condition. If the cooling unit should malfunction without operator's knowledge, Honeywell suggests that a current voltage limiter be installed in the bias circuit to prevent burnout when the detector element warms.

Normally, meters used to measure resistance have a 1.5 volt battery. The current generated by the battery is sufficient to burnout the detector. Therefore, if resistance must be measured, observe the following:

A. Use Wheatstone bridge with an external battery to produce a current/voltage level compatible with Honeywell's test results.

B. When the detector is in an operating circuit or system, use a VTVM with selector switch set to VOLTAGE. Read voltage drop across detector and compute resistance by Ohm's Law. Be cautious of power ground loops between the VTVM and detector circuitry. Connect common ground first, then connect VTVM to high side of detector. If VTVM is of a high impedance, use a series limiting resistance in VTVM lead. Resistance values up to 1% of VTVM input impedance will cause no voltage reading errors.

If in usage, it is necessary to expose this device to elevated temperatures, do not exceed +65°C.

Lead Soldering: Use a low melting temperature solder on leads attached to the detector pins. The detector wires are soldered to the pins with 115°C melting temperature solder. The feed thru pins are extremely short. Do not allow the temperature to build up to the point where detector wires become unsoldered. Use a well grounded iron or heat tip to melt solder then disconnect power cord from socket prior to soldering the leads to the pins.